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ABSTRACT

This Technology Learning Activity (TLA) for control robotics programming technology in grades 6-10 is designed to teach students to construct and program computer-controlled devices using a LEGO DACTA set and computer interface and to help them understand how control technology and robotics affect them and their lifestyle. The suggested time for this activity is 8 days. Introductory materials provide an overview of technology education and information on using the two parts of the TLA: the instructor's guide and the student guide. The instructor's section provides the following: an overview of technology education, a list of high priority academic student skills specific to the TLA, a summary of activities and supplies needed for students to complete the TLA, a resource list, an instructional sequence (daily lesson plans with suggested daily assignments; equipment, tools, and supplies needed for each student; column for facility requirements or modifications), a supplies and materials worksheet, pretest and posttest, written exam answer sheets, and evaluation summary for the TLA. The student's section provides daily activities for each of the 8 days. Within the daily activity pages are these components common to all TLAs: summary of activities, pretest instructions, list of assignments to turn in, goal, glossary, list of priority academic students skills reinforced by this TLA, list of objectives, related Technology Student Association competitive event(s), and academic and workplace applications. (YLB)

ED 383 935

Technology Learning Activity

CONTROL ROBOTICS PROGRAMMING TECHNOLOGY

TLA TE-1106

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CIMC

Teacher Edition

Oklahoma Department of
Vocational and Technical Education
1500 West Seventh Avenue
Stillwater, OK 74074-4364

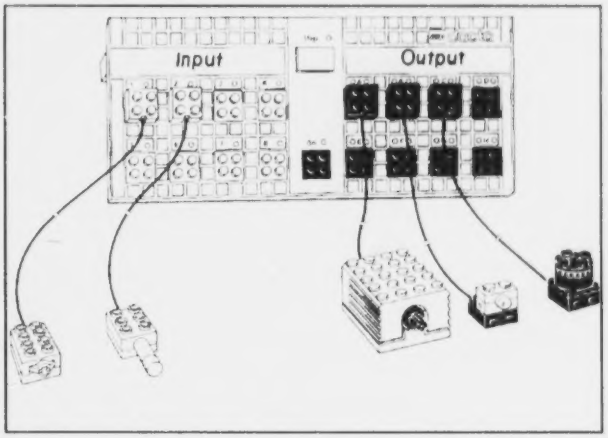
TECHNOLOGY EDUCATION

TECHNOLOGY LEARNING ACTIVITY

TE1106

CONTROL ROBOTICS PROGRAMMING TECHNOLOGY

Suggested Time: 8 Days



Developed by the
Curriculum and Instructional Materials Center
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Oklahoma Department of Vocational and Technical Education

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FOREWORD

What will be the careers of the future? The workforce of tomorrow will be shaped by the technologies being developed today. Students today need accurate, interesting information on growing technologies in order to make informed decisions about their futures.

It is our hope that this curriculum will help improve the quality of career decisions for our students. Students are introduced to a wide range of current, "cutting-edge" technologies and are encouraged to think critically about how those technologies influence their lives and futures. Today's students do not have to become the victims of "technological illiteracy," but instead can learn to anticipate technological developments and take positive steps to prepare for the future.

Technology Learning Activities provide students with the knowledge and an introduction to the skills they need for a positive learning and career experience. Every generation is faced with learning how to manage technological advances. Information gained through participation in the Technology Education program can help students develop a holistic view of technology on which to base their educational and career decisions.

Roy Peters, Jr., Ed.D., State Director
Oklahoma Department of
Vocational and Technical Education

Lynn Hawkins, State Supervisor
Technology Education
Oklahoma Department of
Vocational and Technical Education

PREFACE

We believe that one of the most effective ways to improve education is through the development and implementation of a sound instructional materials system. Technology Education instructional materials represent a new design for CIMC which recognizes the importance of graphic materials in the learning process.

Technology Education instructional materials are designed for 6th through 10th grade students. The design of these materials is based on current research on how people read and gain information from documents. The design is called "New Look" and integrates both graphics and text into a balanced presentation which is easy to use and follow.

Technology Education provides the student a look at what the world will be like in the future based on technologies in use and being developed today. Throughout the Technology Education instructional materials, the students are introduced to "cutting-edge" technologies that they will use and encounter in a working environment later in life. This exposure gives them a wide range of experiences on which to base career decisions.

This publication is intended as a starting point, from which the teacher can innovate, localize, and personalize in order to prepare students for their future. The Technology Education series of Technology Learning Activities was written with the realization that we are creating the workforce of tomorrow by how and what we teach about technology today.

Ann Wolfe, Instructional Design Specialist
Curriculum and Instructional Materials Center
Oklahoma Department of
Vocational and Technical Education

ACKNOWLEDGEMENTS

The Curriculum and Instructional Materials Center (CIMC) extends its appreciation to those individuals who played important roles in the development of Technology Learning Activity materials.

Generous thanks is extended to Lynn Hawkins, formerly a Technology Education teacher and currently State Supervisor, and Jim Harder, a Technology Education teacher at Mayfield Junior High School, for the time, talent and knowledge they contributed in determining the content of this Technology Learning Activity (TLA).

We also thank the State Director, Dr. Roy Peters, Jr., and the Assistant State Director, Dr. Charles O. Hopkins, for their continued support throughout this project.

Oklahoma Department of Vocational and Technical Education Technology Education staff who provided leadership and direction on this project also deserve special recognition.

Lynn Hawkins
State Supervisor
Technology Education

Donovan Bowers
Assistant State Supervisor
Technology Education

Harold Holley
Assistant State Supervisor
Technology Education

Appreciation and gratitude is extended to Mr. John R. Brown and Greg Tortoreti, Educational Consultants and LEGO DACTA®, LEGO® Systems Inc. for their guidance and assistance in the development of this TLA.

Only through the close cooperation of the Curriculum and Instructional Materials Center staff was this curriculum developed. Sincere thanks are shared with the CIMC coordinators.

John Friedemann
CIMC Coordinator

Lynna Ausburn, Ph.D.
CIMC Development Coordinator

Special recognition and thanks are also extended to other individuals within the Oklahoma Department of Vocational and Technical Education (ODVTE) involved in the development and distribution process: Danny Darrow and Diane Ensign and their staffs at the ODVTE Print Shop; Bob Davis and staff artist Kathryn Moore for the cover design; Darrell Stiles and his staff in the ODVTE Warehouse for packaging and coordinating transportation and distribution of these materials.

Finally, a big thank you to all ODVTE team members who offer their support on a daily basis in "behind-the-scenes" ways but never seem to be recognized for their contributions: Suzanne Perry and Terri Tomson, CIMC secretaries; Shirley Hill and Beverly Mealer, Technology Education secretaries.

TECHNOLOGY EDUCATION OVERVIEW

About the Program

Because the American culture is distinctly characterized as technological, it becomes the function of our schools to give every student an insight into and an understanding of the technological nature of the culture. Technology Education strives to perform this function.

Technology Education in Oklahoma is an instructional program that provides young men and women (grades 6-10) with daily, hands-on exploratory experiences and insights into technology and career opportunities so that they can make meaningful occupational and educational choices. It is a program which can enhance the educational experience of all students, whether they are the valedictorian/honor-type student, the middle range/average student, or the student who has found little success in school, namely the at-risk student.

Technology Education acquaints all students with their technological environment so they can make rational decisions about their own lives on a day-to-day basis and participate in controlling their own destiny. The program directs students to related technological and industrial fields, enabling students to realize their full potential and make maximum use of their individual talents in fulfilling career goals in their selected areas of employment.

Technology education capitalizes on the individual's potential for reasoning and problem solving, for imagining and creating, and for constructing and expressing through the use of tools and materials related to technology. It develops content and experiences to contribute to the growth and development of students commensurate with their potential. Thus, Technology Education is a basic and fundamental study for all persons in regard to career explorations and educational opportunities.

TECHNOLOGY EDUCATION OVERVIEW

Opportunities to develop and apply leadership, social, civic, and technologically related skills are provided through the Technology Student Association (TSA). TSA is the appropriate vocational student organization identified as a teaching tool for teachers to use in assisting students to achieve identified course competencies. Competency-based activities are an integral part of the instructional program.

All Technology Education courses are taught in a one-period block of time (45-55 minutes), with each of the four Technology systems (communication, construction, manufacturing, and transportation, energy and power) being designed to provide a means through which other courses such as math, science, English, and social studies can be applied in a practical manner within a technology-based situation. Teaching across the curriculum is vital to the success of a Technology Education program.

TECHNOLOGY EDUCATION OVERVIEW

About the TLAs

The Technology Education series consists of 40 Technology Learning Activities (TLAs) for instruction and a supplemental activities book. Each TLA is divided into two parts: an instructor's guide and a student guide. The instructor's guide provides an overview of Technology Education, a summary of activities and supplies needed for students to complete the Technology Learning Activity, a supplies and materials worksheet for the instructor, an overview of the particular TLA, written exam answer sheets, and evaluation summary for the TLA.

Master copies of the evaluation summary sheets, pretest and posttest, and supplies and materials worksheets are provided with this instructors edition of the TLA. These sheets may be reproduced for classroom use.

All of the TLAs focus on measurable and observable learning outcomes. Instructors are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

TLAs are designed for use in more than one class period of instruction. Careful study of each TLA by the instructor will help her or him determine the following:

- >>> Skills to demonstrate
- >>> Supplies and equipment needed
- >>> Amount of time needed for student practice
- >>> Workstation Bookshelf, Instructors Reference Materials, and a bibliography are provided for supplemental resources
- >>> Supplementary materials, including print and non-print media to order
- >>> Resource people to contact
- >>> Facility modifications which may be necessary to administer the TLA

TECHNOLOGY EDUCATION OVERVIEW

Each TLA is based on performance objectives. Performance objectives are specific, stating the performances necessary to meet the goal of the TLA.

The overall goal of the unit tells what the student should be able to do and what standard will be used to determine whether the student has achieved competency. The specific objectives outline the sequence of the competencies required to meet the TLA goal. The competencies may be either cognitive, requiring knowledge only, or psychomotor, requiring knowledge and skill.

TECHNOLOGY EDUCATION OVERVIEW

About Ordering TLAs

Additional TLAs in the Technology Education series may be ordered through the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, OK 74074-4364. Phone 1-800-522-5810.

☑**NOTE:** Instructor's Editions have order numbers in the 1100 series (for 8-Day TLAs) and 1200 series (for 6-Week TLAs). Student Editions have numbers in the 3100 series (for 8-Day TLAs) or 3200 series (for 6-Week TLAs).

Corrections and Suggestions

CIMC wants to provide Technology Education instructors and students materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications or have suggestions for improving their usefulness, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and indicate the correction on the copy. Mail this information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Curriculum Development Coordinator
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

USING THIS PUBLICATION

INSTRUCTOR'S SECTION

Background Information

The background information component provides instructors with basic information about the subject of the TLA. Instructors are encouraged to use suggested resources for additional information on the specific technology used in each TLA.

Priority Academic Student Skills

There are 14 Priority Academic Student Skills for the Technology Education series. Not every TLA fulfills all 14 Priority Academic Student Skills, so outcomes specific to each TLA are listed in the Instructors Section and in the Students Section. The 14 Priority Academic Student Skills for the Technology Education series are:

- The student will know and appreciate the importance of technology and technological literacy.
- The student will explore career opportunities so they can make meaningful occupational choices.
- The student will explore future educational opportunities so they can make meaningful educational choices.
- The student will apply problem solving and critical thinking techniques.
- The student will apply math, science, reading, and other school subjects in a practical situation.
- The student will develop keyboarding and computer literacy skills.
- The student will develop basic skills in the safe and proper use of tools, machines, materials, processes, and technical concepts.
- The student will think logically and sequentially.
- The student will develop leadership, creative abilities, positive self-concepts, and individual potential in a technological society.
- The student will develop an understanding and the ability to adapt to those technological forces that influence life in the 21st Century.

USING THIS PUBLICATION

INSTRUCTOR'S SECTION

- The student will develop an understanding of economic development.
- The student will communicate by making clear and relevant points through the development of mental process skills.
- The student will apply design, imagination, and creative abilities.
- The student will explore the organization and management systems of business and industry.

Suggested Activities

The suggested activities component is designed to assist during the preparation stage of the teaching/learning process. The activities provide suggestions for preparation and evaluation during the instructional process. The instructor should read the suggested activities before assigning the TLAs to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resource persons. Duties of the instructor will vary according to the particular TLA.

Suggested Resources

Suggested resources, include people, as well as print and non-print media that may be used with the TLA. References used during the development of each TLA are also provided. The instructor can use suggested resources and TLA references to supplement her or his knowledge of the subject to help students with particular interests or objectives in the area covered. Please note that suggested resources and references listed in this publication existed when this publication was written. CIMC assumes no responsibility for providing these materials and cannot ensure the availability of these materials as individual vendors, manufacturers, and publishers may discontinue these products at any time.

USING THIS PUBLICATION	INSTRUCTOR'S SECTION
Instructional Sequence	This component provides instructors with daily lesson plans for the TLA. Included in the instructional sequence component are suggested daily assignments and equipment, tools, and supplies that will be needed for each student. A column for facility requirements or modifications is provided for each instructor. This component is provided as a guide to plan for and monitor students' progress through the TLA.
Equipment, Tools, and Supplies: Summary Worksheet	This component is provided as a planning tool for instructors. It provides instructors with a list of the necessary equipment, tools and supplies to support student activities and provides specific information for budgeting purposes.
Pretest and Posttest	These components provide criterion-referenced evaluation of the objectives listed in each TLA. If objectives or activities have been added, deleted, or modified, appropriate changes should be made on the tests.
Test Answers	This component is provided to assist instructors in evaluating student performance on written tests.
Evaluation Summary	This component is provided to assist instructors in summarizing the performance of each student on an individual basis. The evaluation summary forms are also provided as photocopy masters for the instructors use.

USING THIS PUBLICATION

STUDENT'S SECTION

Introduction

Daily activities are the step-by-step procedures students will follow to complete the learning experience. Each TLA is organized by daily tasks and activities. Students are able to pace their progress through the TLA by referring to the activities for the day.

Within the daily activity pages are components common to all TLAs.

Summary of Activities

A Summary of Activities page begins each day of the TLA. This page provides several important pieces of information for both the student and instructor.

1. In the left column this page provides the student with a list of activities to be accomplished that day.
2. In the right column the major Academic and Workplace Application which applies to that day's activities is graphically indicated with a standard icon.
3. Below the icon is a list of specific skills reinforced during that day's activities.

Pretest Instructions

The students are required to take a Pretest as one of the first day's activities. The instructions for the Pretest are given in this section.

Assignments to Turn In

Day One includes a list of all assignments the students are expected to turn in during or at completion of the TLA. This list includes all tests, activities, and products covered in the TLA.

Goal

On Day One, following the assignments checklist, is a concise statement of the overall goal of the TLA. This statement summarizes the purpose for completing the TLA and encourages the student to think about the broader implications of the learning experience.

USING THIS PUBLICATION

STUDENT'S SECTION

Words You Should Know

The first day's activities includes a glossary of unfamiliar technical terms used in the TLA. Often these terms are necessary for the student in order to accurately follow instructions in the activity procedures. The students should be encouraged to review this glossary and refer to it often during the course of the TLA.

Priority Academic Student Skills Reinforced by this TLA

As stated in the guide to the Instructor's Section, there are 14 identified Priority Academic Student Skills associated with the Technology Education series. This section of Day One activities lists the Priority Academic Student Skills that specifically apply to the TLA. A student who reviews this list will gain a better understanding of the scope of experiences and skills to be gained from the TLA.

Objectives

Each TLA is made up of a set of measurable objectives. In this section on Day One, students are given a list of all the objectives addressed in the TLA. This list can serve to introduce students to the flow of the TLA as they build introductory skills in a technology.

Related TSA Competitive Event(s)

Each TLA may be used by students to begin work toward completion of a Technology Student Association competitive event. Some TLAs are tied to a specific TSA event; other TLAs may be used with several events. This Day One section gives the student and instructor a list of appropriate TSA events which the TLA may support.

TSA competitive events promote leadership development, and an understanding that winning isn't everything but involvement is. Events are staged at Local, Regional, State, and National levels.

USING THIS PUBLICATION

STUDENT'S SECTION

Academic and Workplace Applications

The curricular content and activities found in this Technology Learning Activity help students apply academic and workplace competencies. These competencies include: Reading Skills, Writing Skills, Mathematics Skills, Science Skills, Oral Communications Skills, Interpersonal or Relating Skills, Creative Thinking and Problem Solving Skills, Employability Skills, and Social Studies Skills.

Preparing students to enter successfully into today' world . . .

Preparing students to enter successfully into today's world of work offers vocational education a substantial challenge. The contemporary workplace is characterized by constant and rapid technological change and by increasing job complexity and skill intensity. Due to rapid technological advancement, the half-life of work skills is now reduced to a bare three to five years. Out of this new workplace environment has arisen a growing national awareness of the critical importance of an American workforce armed with the skills necessary to survive in a competitive economy.

. . . emergence of a renewed emphasis on basic academic skills . . .

One result of this national awareness has been the emergence of a renewed emphasis on basic academic skills in all areas of education. Pressure to increase academic skill development is being placed on education by both legislative action and industry mandate. The Carl D. Perkins Vocational and Applied Technology Education Act of 1990 sets stringent academic and workplace skill requirements for vocational education. State legislatures are increasingly requiring basic skills accountability by teachers and school administrators.

. . . expected learner outcomes are being implemented with increasing frequency.

Graduation exams, minimum competency requirements, and expected learner outcomes are being implemented with increasing frequency. In addition, business and industry are delivering the message clearly to educators that vocational competence now requires increased strength in academic and workplace skills.

USING THIS PUBLICATION

STUDENT'S SECTION

The issue of basic skills . . . was successfully addressed in a national three-year study . . .

The issue of the basic skills currently required in the work place was very successfully addressed in a national three-year study conducted jointly by the American Society of Training and Development (ASTD) and the U.S. Department of Labor (DOL). The findings of this study were published in 1990 in the book, Workplace Basics: The Essential Skills Employers Want.

. . . research indicates clearly that American employers . . . need a variety of skills . . .

The ASTD/DOL research indicates clearly that American employers have discovered that their workforces need a variety of skills that include, but are not limited to, the classic academic trio of reading, writing, and computation. Employers now are also looking for competence in areas such as "learning to learn," problem solving and critical thinking, interpersonal and teamwork skills, oral communication and listening techniques, and the social and personal management skills that demonstrate a capacity for independence and responsibility in on-the-job performance.

. . . business and industry have expanded and redefined "workplace basics."

It is clear that the requirements of today's business and industry have expanded and re-defined "workplace basics." It is in line with this re-definition, and with the competency requirements of current education legislation, that the Oklahoma Department of Vocational and Technical Education has chosen to address "basic skills" in the instructional materials produced by its Curriculum and Instructional Materials Center.

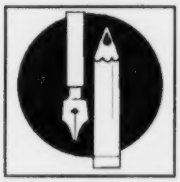
CIMC materials contain information and activities which develop academic and workplace application competencies . . .

It is not a new development for CIMC materials to contain information and activities which develop academic and workplace application competencies in students undertaking vocational programs. What is new is the specific marking, or flagging, of items in our instructional materials that address academic and workplace application skills.

USING THIS PUBLICATION

To assist teachers and students in identifying activities which promote academic and workplace skills . . .

READING SKILLS: Skills involving use of print resource material for obtaining and applying information.



WRITING SKILLS: Skills involving written communication of processes, information, or ideas.

MATHEMATICS SKILLS: Skills involving computation, calculation, and interpretation of numerical data.

STUDENT'S SECTION

To assist teachers and students in identifying activities which promote academic and workplace skills development, CIMC has implemented a marking system which uses simple graphic symbols, or icons. These icons are located in the right margins of Activity Sheets. The following is an explanation of the icons and the kinds of academic and workplace application activities they indicate.

Current vocational education literature indicates that functional literacy as a workplace basic needs to be defined in terms of reading competencies actually required for job performance. The activities identified with this icon as addressing reading skills in CIMC materials deal specifically with developing reading skills in an applied, job-related context. These range from general information-gathering activities to tasks requiring use of specific technical reference materials. Many contain a "learning to learn" aspect, which promotes engaging actively and purposefully in vocationally relevant enquiry.

Tasks identified with this icon promote development of skills in written communications. As with reading skills, the writing skills emphasized in CIMC materials have a vocational context. They include filling out forms, keeping work activity records, writing simple memos and letters, generating more complex reports and articles, and written expression of ideas and concepts related to vocational performance or exploration.

This icon identifies activities which develop vocationally-related skills in computation, measurement and estimation, selection and application of appropriate mathematical processes, and collecting, displaying, or interpreting data.

USING THIS PUBLICATION

SCIENCE SKILLS: Skills involving mastery and application of scientific information or theory.

ORAL COMMUNICATION SKILLS: Skills involving speaking and listening.

INTERPERSONAL OR RELATING SKILLS: Skills involving working and getting along with others.

CREATIVE THINKING AND PROBLEM SOLVING SKILLS: Skills involving comprehending, applying, analyzing, and developing complex ideas and situations.

STUDENT'S SECTION

This icon marks activities which are related to the development of skills in either the physical or biological sciences. These skills stress occupationally-related applications of science and technology.

Activities marked with this icon promote development of effective speaking and listening. They include practice in such areas as speaking techniques, word choice, non-verbal messages, use of communication media, and using active listening techniques. Many of these activities promote "learning to learn" skills in verbal enquiry.

Activities which deal directly with skills in relating to others are marked with this icon. This includes areas such as multi-cultural awareness, group processes and dynamics, negotiation, dealing with conflict, cooperation and teamwork, values and attitudes, and leadership and motivation.

This icon identifies activities which stress development of higher-order thought processes such as problem identification and analysis, lateral thinking, evaluating alternatives, developing solutions, examining assumptions, and evaluating outcomes.

USING THIS PUBLICATION

EMPLOYABILITY SKILLS: Skills involving choosing, obtaining, and succeeding in a career.

SOCIAL STUDIES SKILLS: Skills involving investigation and application of social concepts.

STUDENT'S SECTION

Activities marked with this icon relate to competencies required to obtain employment and develop a career. These competencies include specific occupational tasks. They also include items such as career analysis and selection, job searching, completing applications and resumes, interviewing, and business etiquette and personal management skills required for job-keeping and maturing in one's work. Examples of the latter category include personal presentation, self-discipline, work accuracy, reliability, discretion, punctuality, stress handling, judgement, confidence, etc.

This icon marks activities which stress competencies in fields relating to human society and its distribution and relationships. This includes areas such as history, geography, government and politics, economics, psychology, sociology, demographics, current events, cross-cultural studies, consumer issues, environmental issues, and ethical concerns in science and technology.

USING THIS PUBLICATION

Impact Statements

STUDENT'S SECTION

There are five areas of human culture for which each TLA has an impact. These impact statements appear during Day Eight, after the student has gained some familiarity with the technology.

1. ENVIRONMENTAL IMPACT: A statement introducing the student to the impact of the technology on the environment.
2. SOCIAL/CULTURAL IMPACT: A statement concerning the impact of the technology on society and culture.
3. ECONOMIC IMPACT: A statement concerning the impact of the technology on the economy.
4. POLITICAL IMPACT: A statement concerning the impact of the technology on politics, laws, and regulations, and the impact of politics on the development of the technology.
5. ERGONOMIC IMPACT: A statement concerning the ergonomic implications of the technology. Ergonomics is the study of developing products and systems that meet peoples' needs.

Impact Statements offer the student the opportunity to see beyond the activities in the Technology Learning Lab and glimpse the real-world applications of the technology.

USING THIS PUBLICATION	STUDENT'S SECTION
Career Search	Also on Day Eight, the students are given the assignment of investigating several career opportunities related to the technology of the TLA. The investigation is done with Career Search Abstracts. A list of up to five careers related to the TLA is given, followed by pages from Career Search Abstracts that detail the career qualifications and work environment. The student is required to choose two of the five related careers, read the appropriate abstracts, then write a short essay about why those careers may be appealing.
Posttest Instructions	The students are required to take a Posttest as one of the last day's activities. The instructions for the Posttest are given in this section. The score for the Posttest may be compared to the score for the Pretest to help determine the student's gain during the TLA.
Skunk Works	Skunk Works, a Day Eight optional activity, includes instructions that could be used for solving problems or reinforcing the enrichment of learning. The term Skunk Works was coined by engineers at 3M Corporation in the mid-1960s. Some engineers wanted to develop a new product, but company management would not give them the time or money to work on the project. So the engineers "borrowed" time and money from approved projects to work on their "Skunk Works." When they finished developing the product, they presented it to management and it has been a 3M product ever since. The product: Velcro fasteners.

HAZARD ALERT MESSAGES

The Daily Activities include hazard alert information specific to the Activity. These messages should be discussed carefully and thoroughly. The Hazard Alert Message system used in the TLA is based on the American National Standards Institute (ANSI) Standard Z535, which provides for five levels of alert.

Students are introduced to the ANSI Hazard Alert Message system as an activity in the Laboratory Safety for Construction Technology TLA (TE1107/TE3107). This system was adopted by ANSI as the standard in 1990 and will be the hazard alert system in use when students reach the workplace.

Hazard Alert Messages in the TLA are indicated both by the color red and graphically. There are three types of hazard alert graphics used in the TLA: the hazard alert symbol, injury hazard graphics, and avoidance graphics.

This Hazard Alert Symbol is used with the words **DANGER, WARNING,** and **CAUTION.** ANSI defines these words as:

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

HAZARD ALERT MESSAGES

There are two types of graphics used in conjunction with the hazard alert symbol. This type of graphic depicts a specific injury that may be expected if the hazard described in the alert is not avoided.

This second type of graphic is called an avoidance graphic. It depicts an action the student should take in order to avoid injury.

There are two other ANSI words used in the TLAs and the students should understand their meanings:

NOTICE indicates an action that could result in damage to property or equipment.

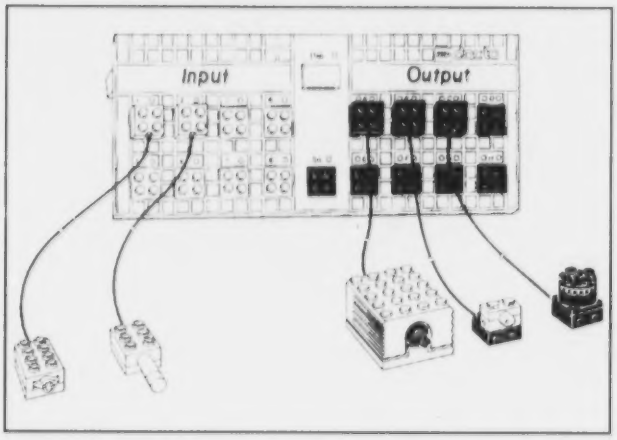
IMPORTANT indicates an instruction that can help the student do a better job.

TECHNOLOGY EDUCATION

CONTROL ROBOTICS
PROGRAMMING TECHNOLOGY

TE 1106/3106

INSTRUCTOR'S SECTION



BACKGROUND INFORMATION

Humans have been inventing devices to lighten their work load since the time of our prehistoric ancestors. As these devices increased in power and complexity, the need for greater control has become increasingly more important. Loss of control, or lack of control has resulted in untold misery. Everyone can relate to the weekend gardener who loses control of his power-driven lawn mower and destroys the flower beds, flattens the kiddie pool, and gives Fido an unscheduled haircut.

There is no better example of the need for control than the supersonic jet fighter. To fly this plane at such high speeds, the pilot is dependent upon sensors and computers to process information. Without this equipment, it would be impossible to control and fly the plane safely.

The environment inside today's office buildings is controlled through sensors and processors. Many of these buildings have windows that do not open. Sensors throughout the building monitor the temperature. That information is collected, processed, and, if needed, signals are sent from the processor that adjust the heat or air conditioning.

Much of the control technology we use today was developed for convenience. Doing the family laundry is a chore made easier with control technology. Today's washing machines have cycles that are controlled automatically with timers, water levels that can be preset for large or small loads, agitation levels that can be set for gentle or heavy duty, and even water temperatures that can be preset and monitored. Many other modern appliances also make life easier using control technology.

Even though the jet fighter, the office building, and the washer are very different, they have three things in common—a sensory system where information is gathered, a processor

INSTRUCTOR'S SECTION

BACKGROUND INFORMATION

where this information is processed, and something to do with the processed information. The information taken into the processor is called input. The altitude information the pilot receives, the temperature readings in the building , and the water temperatures in the washing machine are all examples of input. The processor takes the information in, processes the information, and then sends the information out in a variety of ways.

The one device that people most often associate with the input—process—output procedure is a computer. A computer receives information (input), often through a keyboard. The CPU (central processing unit) processes the information and then sends the output to a variety of output devices such as a computer screen or printer. When the CPU receives and processes the input information, it follows a set of directions called a program. The program tells the CPU what to do with the information received. The CPU actually gets the program's directions as a series of logical "on"(1) and "off"(0) commands, but the program itself can be written in one of the many computer languages we humans more easily understand Some of these languages are COBOL, FORTRAN, C, BASIC, and LOGO.

Just as people who speak different languages use an interpreter to communicate, the computer uses an interpreter to translate the information it receives in a computer language into the 1's and 0's it understands. It then uses these 1's and 0's to set millions of switches to either on or off. Although computer languages like LOGO require us to learn some special words, they are much easier to understand than 1101000 1100101 1101100 1101100 1101111 which, in computer language says Hello.

INSTRUCTOR'S SECTION

BACKGROUND INFORMATION

Computers can receive input from a variety of sources. The interface between the computer and the input/output devices is an essential link in control technology. Generally speaking, the greater the number of input and/or output devices that can be connected to an interface, the more sophisticated (and expensive) that interface is.

An interface enables the processor to communicate with other devices. In industrial manufacturing operations, interfaces and processing units known as Programmable Logic Units (PLUs) are used to control the various machines on an assembly line. For example, when LEGO® bricks are packaged, the box must stop at a specific points along an assembly line to receive a certain number of a specific LEGO® piece. Sensors along the line keep track of both the speed and the number of boxes that are being filled. Scales weigh each box as it passes from station to station. The weight of the box is sent to the processor. If the weight of the box is not exactly what it should be, it is an indication that this particular box did not receive the correct amount of LEGO® pieces. The processor then sends a signal to an automated device, and the box is removed from the line. If several boxes all have the same incorrect weight, this is an indication to the processor that there is a problem in another part of the packaging line. The computer then processes this information and either corrects the problem automatically or sends a signal to a person on the line that a correction needs to be made.

An interface connects the CPU of the computer to the outside world. The computer may receive input from a variety of devices including keyboards, joysticks, tracker balls, and mice. The information is then processed and sent to an output device such as a monitor, printer or other speciality device.

INSTRUCTOR'S SECTION

BACKGROUND INFORMATION

The Control Lab™ interface box used in this TLA acts as both an input and an output device. It can gather information from touch sensors, light sensors, temperature sensors and rotation sensors. It can also provide output to motors, lights and to sound elements.

As computers become faster and more capable of handling larger amounts of information, the need for easier and faster methods of input has increased. Advanced input technologies are rapidly expanding and today include items that allow users to communicate with computers more naturally. Devices such as handwritten notepads, controller gloves, voice control, and even eye tracking systems are being refined. Sensors that provide input are increasing in number and complexity every day. Whatever lies ahead in the 21st century, a working understanding of basic control systems will provide a basis for learning the control systems of the future.

INSTRUCTOR'S SECTION

PRIORITY ACADEMIC STUDENT SKILLS

- The student will know and appreciate the importance of technology and technological literacy.
- The student will explore career opportunities so they can make meaningful occupational choices.
- The student will explore future educational opportunities so they can make meaningful educational choices.
- The student will apply problem solving and critical thinking techniques.
- The student will apply math, science, reading, and other school subjects in a practical situation.
- The student will develop keyboarding and computer literacy skills.
- The student will develop basic skills in the safe and proper use of tools, machines, materials, processes, and technical concepts.
- The student will think logically and sequentially.
- The student will develop leadership, creative abilities, positive self-concepts, and individual potential in a technological society.
- The student will develop an understanding and the ability to adapt to those technological forces that influence life in the 21st Century.

INSTRUCTOR'S SECTION

PRIORITY ACADEMIC STUDENT SKILLS

- The student will communicate by making clear and relevant points through the development of mental process skills.
- The student will apply design, imagination, and creative abilities.

INSTRUCTOR'S SECTION

SUGGESTED ACTIVITIES

- ✓ Obtain materials to supplement TLA. See Suggested Resources for computer software and books to supplement this module.
- ✓ Review instructional outline for this TLA. Modify time frames to suit class needs and plan activities for each class period.
- ✓ Study the specific objectives to determine those you will cover in your presentation. Also decide which objectives should be taught to which students.
- ✓ Determine scope and sequence of objectives that you add to the TLA. Design and develop support materials, including evaluation techniques, for additional objectives.
- ✓ Determine how you will schedule time for students to demonstrate competence in the required procedures.
- ✓ Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of this TLA.
- ✓ Install the LEGO DACTA® computer interface card, the interface box, and the software. Prepare start-up instructions for the students to follow.
- ✓ Practice using the LEGO DACTA® set and computer interface so that you will be familiar with how it works and what it can do.
- ✓ If you haven't already done so, decide how your students will save and print their files.

INSTRUCTOR'S SECTION

PREPARATION

SUGGESTED RESOURCES

Todd, Ronald D., David McCrory, and Karen L. Todd. *Understanding and Using Technology.* Davis Publications, Inc. Worchester, Massachusetts, 1985.

Hacker, Michael and Robert A. Barden. *Living with Technology.* Delmar Publishing Company, Albany, New York, 1993.

For additional references, see pages 6.22–6.24 in the *Control Lab™ Technology Investigations and Inventions* book listed below.

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Control Lab™ Setup Guide and Introductory Explorations. ©LEGO Group, Enfield, Connecticut, 1993.

Control Lab™ Quick Start Guide: Creating a Fan Control Project. ©LEGO Group, Enfield, Connecticut, 1993.

INSTRUCTOR'S SECTION

WORKSTATION BOOKSHELF

INSTRUCTOR'S REFERENCE MATERIALS

Instructional Sequence	Technology Education: Control Robotics Programming Technology		
	Assignments	**Equipment, Tools, and Supplies**	**Facilities Requirements/ Modifications**
Day 1	Take Pretest. Read and study the Assignment Checklist, Words You Should Know, Priority Academic Student Skills, TSA Competitive Events, and Academic and Workplace Skills. Complete Objective 1: Use the computer model to identify the parts of the Control Lab™ serial interface. Complete Objective 2: Properly connect motors, lights, and sensors to the Control Lab™ serial interface.	Computer Score Sheet/card or notebook paper for Pretest LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)	
Day 2	Complete Objective 3: Follow a sequential set of building plans to construct a vehicle that is powered and steered using two independent drive trains.	Building Card 4 from the Control Lab™ Technology set (9701)	
Day 3	Complete Objective 4: Control a model using three types of input. Complete Objective 5: Program your wheelchair to turn 90° and 180°. Complete Objective 6: Write the advantages and disadvantages of each type of control.	LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701) Wheelchair from Day 2 Protractor and yardstick or meter stick	
Day 4	Complete Objective 7: Create a button to control the motion of a model.	LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701) Wheelchair from Day 2	

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Instructional Sequence	Technology Education: Control Robotics Programming Technology		
	Assignments	**Equipment, Tools, and Supplies**	**Facilities Requirements/ Modifications**
Day 5	Complete Objective 8: Describe the difference between primitives and procedures. Complete Objective 9: Name the parts of a procedure and explain what each part does. Complete Objective 10: Write a procedure to operate motors, lamps, or sound elements.	LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701) Sound element Lamp 2 Connecting Leads	
Day 6	Complete Objective 11: Demonstrate the use of variable versus binary inputs using input components from the LEGO DACTA® Control Lab™ building set. Complete Objective 12: Construct monitor boxes to display input values. Complete Objective 13: Control the speed and direction of a motor-driven LEGO model by using feedback from a Control Lab™ angle sensor and touch switch. Complete Objective 14: Follow a sequential set of building plans to construct a joystick that makes use of angle sensors.	LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701) Wheelchair from Day 2 Touch, angle, and light sensor Axle at least 4 studs long and 1 or 2 wheels Building Card 4 from the Control Lab™ Technology set (9701)	

Instructional Sequence	Technology Education: Control Robotics Programming Technology		
	Assignments	**Equipment, Tools, and Supplies**	**Facilities Requirements/ Modifications**
Day 7	Complete Objective 15: Observe the input and resulting output of a joystick operated device.	LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701) Wheelchair and joystick already built	
Day 8	Complete any incomplete assignments. Read and study Impact Statements. Complete Career Search activities. Take Posttest and Spelling Test. Hand in assignments.	Computer Score Sheet/card or notebook paper for Posttest and Spelling Test	
Skunk Works	Design and test a method of controlling a 2-motor robot using a light sensor	LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701) Wheelchair and joystick already built Light sensor Wide tipped permanent black marker or black electrical tape Sheet of white paper at least notebook size	

Equipment, Tools, and Supplies: Summary Worksheet

Equipment, Tools,and Supplies	Per Student	Per Period	Total Needed	Special Considerations	Cost Per Student	Cost Per Period	Total Needed	Special Considerations
Computer Score Sheet/card or notebook paper	1	1						
LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)		1						
Permanent black marker or black electrical tape		1						
White paper at least notebook paper sized		1						
Protractor		1						
Yard stick or meter stick		1						

PRETEST

1. Which of the following is not an input device?
   a. keyboard
   b. touch screens
   c. monitor
   d. mouse

2. The role of an interface is to
   a. provide more RAM to the CPU
   b. allow the reduction of font space in the text mode
   c. permit the computer to communicate with other devices
   d. provide an alternative to acne creams

3. An icon is
   a. the amount of memory lost due to interfacing
   b. a small picture that appears on the computer screen that represents or symbolizes something else
   c. the amount of bytes processed in one nanosecond
   d. a rock and roll star from 1979

4. A hand-operated input device that gives input along an x-y axis is a
   a. yo-yo
   b. modem port
   c. serial port
   d. joystick

5. Digital input is
   a. data or input that is reduced to binary, on/off electronic signals
   b. data that is input from the numeric keypad
   c. data processed by output devices
   d. data received from a calculator

INSTRUCTOR'S SECTION

PART 1

PRETEST

6. Analog input is
   a. data or input received via a fax or modem
   b. data or input that is digital
   c. data or input that is continuous, with varying voltages
   d. information needed to log onto a communication network

7. A primitive is
   a. a start-up disk or program
   b. a special, reserved word that gives a command in the LOGO language
   c. the primary output device
   d. a throw-back to the prehistoric times

8. A set of instructions that has been assigned a single name is
   a. a procedure
   b. a protocol
   c. a primitive
   d. a pituitary

9. A dialog box is
   a. a box that contains options requesting more information from the user
   b. a box that lists telecommunications ports
   c. a voice-activated input device
   d. the built-in microphone on laptop computers

10. Rules of computer grammar are known as
    a. program dialect
    b. software analysis
    c. feedback
    d. syntax

INSTRUCTOR'S SECTION

PART 2

POSTTEST

11. Which of the following is not an input device?
    a. keyboard
    b. touch screens
    c. monitor
    d. mouse

12. The role of an interface is to
    a. provide more RAM to the CPU
    b. allow the reduction of font space in the text mode
    c. permit the computer to communicate with other devices
    d. provide an alternative to acne creams

13. An icon is
    a. the amount of memory lost due to interfacing
    b. a small picture that appears on the computer screen that represents or symbolizes something else
    c. the amount of bytes processed in one nanosecond
    d. a rock and roll star from 1979

14. A hand-operated input device that gives input along an x-y axis is a
    a. yo-yo
    b. modem port
    c. serial port
    d. joystick

15. Digital input is
    a. data or input that is reduced to binary, on/off electronic signals
    b. data that is input from the numeric keypad
    c. data processed by output devices
    d. data received from a calculator

INSTRUCTOR'S SECTION

PART 1

POSTTEST

16. Analog input is
    a. data or input received via a fax or modem
    b. data or input that is digital
    c. data or input that is continuous, with varying voltages
    d. information needed to log onto a communication network

17. A primitive is
    a. a start-up disk or program
    b. a special, reserved word that gives a command in the LOGO language
    c. the primary output device
    d. a throw-back to the prehistoric times

18. A set of instructions that has been assigned a single name is
    a. a procedure
    b. a protocol
    c. a primitive
    d. a pituitary

19. A dialog box is
    a. a box that contains options requesting more information from the user
    b. a box that lists telecommunications ports
    c. a voice-activated input device
    d. the built-in microphone on laptop computers

20. Rules of computer grammar are known as
    a. program dialect
    b. software analysis
    c. feedback
    d. syntax

INSTRUCTOR'S SECTION

PART 2

POSTTEST

21. axel
22. debugging
23. interface
24. procceedur
25. sensor
26. kontrol
27. roboticks
28. command
29. mechaniclel
30. primitive

INSTRUCTOR'S SECTION

SPELLING TEST

TEST ANSWERS

1. c
2. c
3. b
4. d
5. a
6. c
7. b
8. a
9. a
10. d

11. c
12. c
13. b
14. d
15. a
16. c
17. b
18. a
19. a
20. d

21. b
22. a
23. a
24. b
25. a
26. b
27. b
28. a
29. b
30. a

INSTRUCTOR'S SECTION

PRETEST ANSWERS

POSTTEST ANSWERS

SPELLING TEST ANSWERS

EVALUATION SUMMARY

5 POINTS EACH

Pretest

Career Search

Objective 1: Use the computer model to identify the parts of the Control Lab™ serial interface.

Objective 2: Properly connect motors, lights, and sensors to the Control Lab™ serial interface.

Objective 3: Follow a sequential set of building plans to construct a vehicle that is powered and steered using two independent drive trains.

Objective 4:Control a model using three types of input.

Objective 7: Create a button to control the motion of a model.

Objective 8: Describe the difference between primitives and procedures.

Objective 10: Write a procedure to operate motors, lamps, or sound elements.

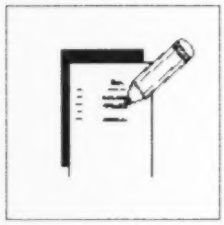
Objective 11: Demonstrate the use of variable versus binary inputs using input components from the LEGO DACTA® Control Lab™ building set.

Objective 12: Construct monitor boxes to display input values.

Objective 13: Control the speed and direction of a motor-driven LEGO® model by using feedback from a Control Lab™ angle sensor and touch switch.

INSTRUCTOR'S SECTION

1. PROCESS EVALUATION



EVALUATION SUMMARY

Objective 14: Follow a sequential set of building plans to construct a joystick that makes use of angle sensors.

Objective 15: Observe the input and resulting output of a joystick operated device.

10 POINTS EACH

Objective 5: Program your wheelchair to turn 90º and 180º.

Objective 6: Write the advantages and disadvantages of each type of control.

Objective 9: Name the parts of a procedure and explain what each part does.

INSTRUCTOR'S SECTION

1. **PROCESS EVALUATION (Continued)**

1. PROCESS EVALUATION SCORE _____

EVALUATION SUMMARY

The instructor is encouraged to individualize the TLA to address the specific needs of each student, considering age and ability level. In addition to the specific areas on the chart below, the instructor should take into account the student's desire, enthusiasm, etc.

Evaluation based upon = 100 possible points, broken down as follows.

EVALUATION RATING TABLE

Student Name: _____

Criteria	Points Possible	Points Earned
Wheelchair Activity	20	_____
Control List Activity	5	_____
Button Activity	20	_____
Procedure Activity	20	_____
Joystick Activity	20	_____
Essay	15	_____

INSTRUCTOR'S SECTION

2. PRODUCT EVALUATION

2. PRODUCT EVALUATION SCORE _____

EVALUATION SUMMARY

Posttest Score: _____

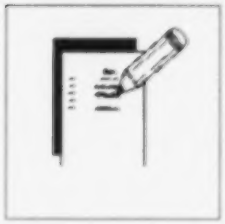
EVALUATION WORKSHEET

1. Process evaluation score = _____
2. Product evaluation score = _____
3. Written evaluation score = _____
4. Total score = _____

Divide Total Score by 3 to get TLA score.

INSTRUCTOR'S SECTION

3. WRITTEN EVALUATION



3. WRITTEN EVALUATION SCORE _____

***Total Score for TLA* =1+2+3**

The *Total Score for TLA* divided by 3 equals the TLA score.

TLA SCORE _____

BIBLIOGRAPHY

Todd, Ronald D., David McCrory, and Karen L. Todd. *Understanding and Using Technology*. Davis Publications, Inc. Worchester, Massachusetts, 1985.

Hacker, Michael and Robert A. Barden. *Living with Technology*. Delmar Publishing Company, Albany, New York, 1993.

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INSTRUCTOR'S SECTION

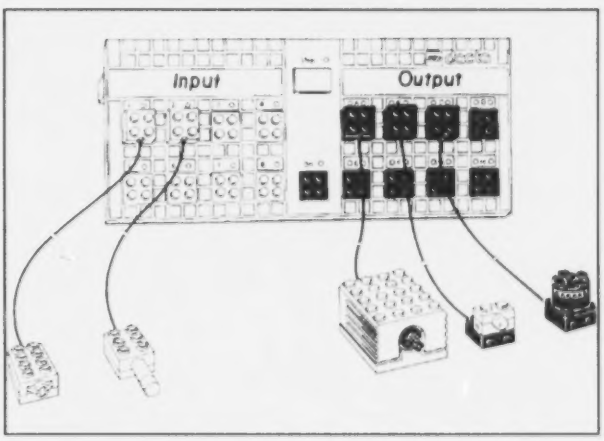
TECHNOLOGY EDUCATION

TECHNOLOGY LEARNING ACTIVITY

TE3106

CONTROL ROBOTICS PROGRAMMING TECHNOLOGY

Suggested Time: 8 Days



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Oklahoma Department of Vocational and Technical Education

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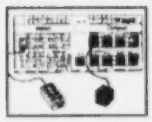
TECHNOLOGY EDUCATION CONTROL ROBOTICS

On Day 1 you should complete the following activities:

1. Complete Pretest
2. Read Assignments to Turn In (items to completed in 8 days)
3. Read Goal
4. Read Words You Should Know
5. Read Priority Academic Student Skills
6. Read Objectives
7. Read Related TSA Competitive Events
8. Read Academic and Workplace Applications
9. Read Information Sheet
10. Complete Objective 1

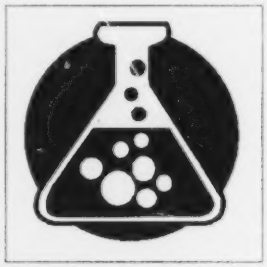
DAY 1 ACTIVITIES



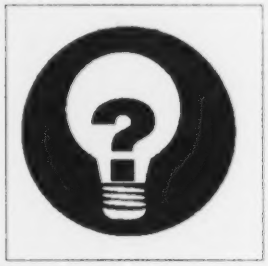
SUMMARY OF ACTIVITIES

Reading Comprehension
- Gain factual information
- Make generalizations
- React to written material

Functional Reading
- Use content area vocabulary



General Science
- Conduct experiments
- Investigate/apply technology



Creative Thinking and Problem Solving
- Apply intuitive thinking techniques
- Apply new technology

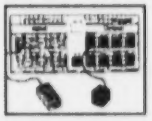
TECHNOLOGY EDUCATION CONTROL ROBOTICS

You will need a computer scan sheet or card to record your answers to the following Pretest. Be sure to write your name, the title of the TLA, the date, and the class period on the computer scan sheet or card using a #2 pencil. Use rows 1-10 to record the answers to the Pretest. If your answers will be hand-scored, use a blank sheet of paper to record your answers and number your answers 1-10.

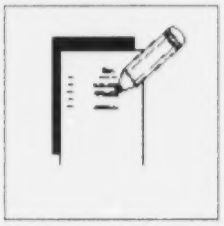
Get Pretest Questions from your instructor.

When you finish the Pretest, return the test form and the computer scan card or notebook paper to your instructor.

DAY 1 ACTIVITIES



PRETEST INSTRUCTIONS

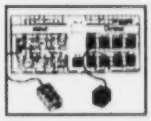


TECHNOLOGY EDUCATION CONTROL ROBOTICS

At the end of 8 days, you should give the following items to your instructor for evaluation:

1. Computer score card/sheet, with answers to:
   a) Pretest
   b) Posttest (including spelling test)
2. Wheelchair Activity
3. List of advantages and disadvantages of control methods.
4. Button/wheelchair Activity
5. Procedure Activity
6. Joystick Activity
7. Career Search Activity
   a) Two careers identified
   b) Explanation of why those occupations appealed to you

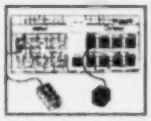
DAY 1 ACTIVITIES



ASSIGNMENTS TO TURN IN

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 1 ACTIVITIES



GOAL

After completing the *Control Robotics Programming Technology* TLA, you will be able to construct and program computer-controlled devices using a LEGO DACTA® set and computer interface. You will understand how control technology and robotics affect you and your lifestyle.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

analog input — continuously varying voltage that controls the action of a processor

binary system — system based on a set of opposites, such as *on* and *off* to count or control; computers use the binary system based on 0 and 1

button — a screen icon that represents a pushbutton that is activated using input devices such as a mouse or touch sensor

control technology — using machines or computers to operate other machines

CPU — abbreviation for central processing unit; the part of the computer that processes the input and sends out the output; also called the processor

dialog box — a screen graphic, often rectangular or square-shaped, that asks for information from the user

digital input — two-state binary input such as on or off

icon — small picture or graphic on the computer's screen that represents or symbolizes something; commands such as copy or print often have icons

input —information put into the computer for processing

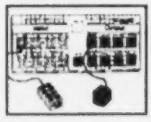
interface box — device connecting lights, motors, and sensors to a computer that changes the information input so that it can be used by the computer or other equipment

LOGO — a computer programming language

output — information sent from the computer after processing

port — set of holes or connecting points in an interface box or a computer

DAY 1 ACTIVITIES



WORDS YOU SHOULD KNOW

TECHNOLOGY EDUCATION CONTROL ROBOTICS

primitive — special reserved words used in the LOGO language that mean specific commands; **onfor** and **setleft** are primitives

procedure — list of primitives grouped together and named; when the primitive is executed, each of the primitives listed will execute

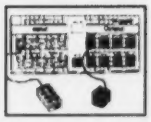
program — series of instructions or commands that can be saved and used again

sensor — device that collects information and sends it to the computer; two types of sensors are optical and touch

syntax — the rules of computer grammar that define the proper order of the command language

touch screen — a special monitor that has a screen with sensors that recognize and detect input from the fingertips

DAY 1 ACTIVITIES

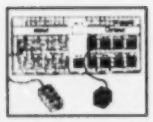


WORDS YOU SHOULD KNOW

TECHNOLOGY EDUCATION CONTROL ROBOTICS

- The student will know and appreciate the importance of technology and technological literacy.
- The student will explore career opportunities so they can make meaningful occupational choices.
- The student will explore future educational opportunities so they can make meaningful educational choices.
- The student will apply problem solving and critical thinking techniques.
- The student will apply math, science, reading, and other school subjects in a practical situation.
- The student will develop keyboarding and computer literacy skills.
- The student will develop basic skills in the safe and proper use of tools, machines, materials, processes, and technical concepts.
- The student will think logically and sequentially.
- The student will develop leadership, creative abilities, positive self-concepts, and individual potential in a technological society.
- The student will develop an understanding and the ability to adapt to those technological forces that influence life in the 21st Century.

DAY 1 ACTIVITIES

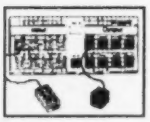


PRIORITY ACADEMIC STUDENT SKILLS

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

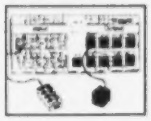
- The student will communicate by making clear and relevant points through the development of mental process skills.
- The student will apply design, imagination, and creative abilities.

DAY 1 ACTIVITIES



TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 1 ACTIVITIES



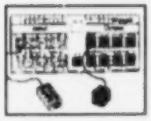
OBJECTIVES

At the completion of this Technology Learning Activity, the you should be able to:

1. Use the computer model to identify the parts of the Control Lab™ serial interface.
2. Properly connect motors, lights, and sensors to the Control Lab™ serial interface.
3. Follow a sequential set of building plans to construct a vehicle that is powered and steered using two independent drive trains.
4. Control a model using three types of input.
5. Program your wheelchair to turn 90º and 180º.
6. Write the advantages and disadvantages of each type of control.
7. Create a button to control the motion of a model.
8. Describe the difference between primitives and procedures.
9. Name the parts of a procedure and explain what each part does.
10. Write a procedure to operate motors, lamps, or sound elements.
11. Demonstrate the use of variable versus binary inputs using input components from the LEGO DACTA® Control Lab™ building set.
12. Construct monitor boxes to display input values.
13. Control the speed and direction of a motor-driven LEGO® model by using feedback from a Control Lab™ angle sensor and touch switch.

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

ACTIVITIES



14 Follow a sequential set of building plans to construct a joystick that makes use of angle sensors.

15. Observe the input and resulting output of a joystick operated device.

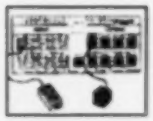
TECHNOLOGY EDUCATION CONTROL ROBOTICS

The following TLA Competitive Events apply to your study of *Control Robotics Programming Technology.*

- Control Technology

See TSA Competitive Events Guidelines for specific details on the competitions.

DAY 1 ACTIVITIES



RELATED TSA COMPETITIVE EVENTS

TECHNOLOGY EDUCATION CONTROL ROBOTICS

The symbols in the right column are used to identify the Academic and Workplace Applications that are reinforced by specific activities in this TLA.

Reading Skills Applied:

Reading Comprehension

- Gain factual information
- Analyze cause and effect
- Draw conclusions
- Make generalizations
- React to written material

Functional Reading

- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary

Writing Skills Applied:

Language Skills:

- Use standard grammar, spelling, and capitalization
- State ideas clearly

Functional Writing

- Use computer graphics

Mathematics Skills Applied:

Functional Math

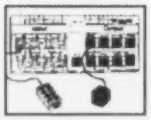
- Make measurements

Science Skills Applied:

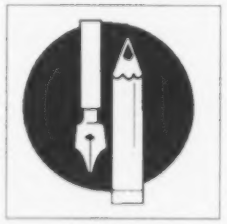
General Science

- Conduct experiments
- Investigate/apply technology

DAY 1 ACTIVITIES



ACADEMIC AND WORKPLACE APPLICATIONS



TECHNOLOGY EDUCATION
CONTROL ROBOTICS

Creative Thinking and Problem Solving Skills Applied:

Cognitive Activities

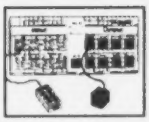
- Collect/record information
- Define a problem
- Apply a problem-solving model
- Analyze/synthesize information
- Draw conclusions
- Devise a solution
- Create a finished product
- Apply intuitive thinking techniques
- Transfer knowledge/training to new situations
- Apply new technology

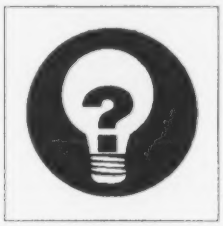
Employability Skills Applied:

Job Search/ Selection

- Analyze personal occupational aptitudes/preferences
- Investigate employment prospects of a career field/occupation
- Investigate training requirements for a career field/occupation
- Investigate benefits of a career field/occupation

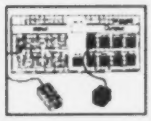
DAY 1 ACTIVITIES





TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 1
ACTIVITIES



INFORMATION SHEET

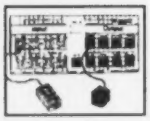
Humans have been inventing devices to lighten their work load since the time of our prehistoric ancestors. As these devices increased in power and complexity, the need for greater control has become increasingly more important. Loss of control, or lack of control has resulted in untold misery. Everyone can relate to the weekend gardener who loses control of his power-driven lawn mower and destroys the flower beds, flattens the kiddie pool, and gives Fido an unscheduled haircut.

There is no better example of the need for control than the supersonic jet fighter. To fly this plane at such high speeds, the pilot is dependent upon sensors and computers to process information. Without this equipment, it would be impossible to control and fly the plane safely.

The environment inside today's office buildings is controlled through sensors and processors. Many of these buildings have windows that do not open. Sensors throughout the building monitor the temperature. That information is collected, processed, and, if needed, signals are sent from the processor that adjust the heat or air conditioning.

Much of the control technology we use today was developed for convenience. Doing the family laundry is a chore made easier with control technology. Today's washing machines have cycles that are controlled automatically with timers, water levels that can be preset for large or small loads, agitation levels that can be set for gentle or heavy duty, and even water temperatures that can be preset and monitored. Many other modern appliances also make life easier using control technology.

Even though the jet fighter, the office building, and the washer are very different, they have three things in common—a sensory system where information is gathered, a processor



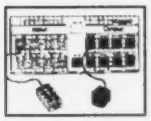
where this information is processed, and something to do with the processed information. The information taken into the processor is called input. The altitude information the pilot receives, the temperature readings in the building , and the water temperatures in the washing machine are all examples of input. The processor takes the information in, processes the information, and then sends the information out in a variety of ways.

The one device that people most often associate with the input—process—output procedure is a computer. A computer receives information (input), often through a keyboard. The CPU (central processing unit) processes the information and then sends the output to a variety of output devices such as a computer screen or printer. When the CPU receives and processes the input information, it follows a set of directions called a program. The program tells the CPU what to do with the information received. The CPU actually gets the program's directions as a series of logical "on"(1) and "off"(0) commands, but the program itself can be written in one of the many computer languages we humans more easily understand. Some of these languages are COBOL, FORTRAN, C, BASIC, and LOGO.

Just as people who speak different languages use an interpreter to communicate, the computer uses an interpreter to translate the information it receives in a computer language into the 1's and 0's it understands. It then uses these 1's and 0's to set millions of switches to either on or off. Although computer languages like LOGO require us to learn some special words, they are much easier to understand than 1101000 1100101 1101100 1101100 1101111 which, in computer language says Hello.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 1 ACTIVITIES



Computers can receive input from a variety of sources. The interface between the computer and the input/output devices is an essential link in control technology. Generally speaking, the greater the number of input and/or output devices that can be connected to an interface, the more sophisticated (and expensive) that interface is.

An interface enables the processor to communicate with other devices. In industrial manufacturing operations, interfaces and processing units known as Programmable Logic Units (PLUs) are used to control the various machines on an assembly line. For example, when LEGO® bricks are packaged, the box must stop at a specific points along an assembly line to receive a certain number of a specific LEGO® piece. Sensors along the line keep track of both the speed and the number of boxes that are being filled. Scales weigh each box as it passes from station to station. The weight of the box is sent to the processor. If the weight of the box is not exactly what it should be, it is an indication that this particular box did not receive the correct amount of LEGO® pieces. The processor then sends a signal to an automated device, and the box is removed from the line. If several boxes all have the same incorrect weight, this is an indication to the processor that there is a problem in another part of the packaging line. The computer then processes this information and either corrects the problem automatically or sends a signal to a person on the line that a correction needs to be made.

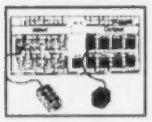
An interface connects the CPU of the computer to the outside world. The computer may receive input from a variety of devices including keyboards, joysticks, tracker balls, and mice. The information is then processed and sent to an output device such as a monitor, printer or other speciality device.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

The Control Lab™ interface box used in this TLA acts as both an input and an output device. It can gather information from touch sensors, light sensors, temperature sensors and rotation sensors. It can also provide output to motors, lights and to sound elements.

As computers become faster and more capable of handling larger amounts of information, the need for easier and faster methods of input has increased. Advanced input technologies are rapidly expanding and today include items that allow users to communicate with computers more naturally. Devices such as handwritten notepads, controller gloves, voice control, and even eye tracking systems are being refined. Sensors that provide input are increasing in number and complexity every day. Whatever lies ahead in the 21st century, a working understanding of basic control systems will provide a basis for learning the control systems of the future.

DAY 1 ACTIVITIES



TECHNOLOGY EDUCATION CONTROL ROBOTICS

Use the computer model to identify the parts of the Control Lab™ serial interface.

Properly connect motors, lights, and sensors to the Control Lab™ serial interface.

➢ LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)

☑**NOTE:** Before beginning this TLA, you should be familiar with the basic operation of the computer you will be using. You should be able to use a mouse to do the following:

- **Point** to an object
- **Click** on an object to select it
- **Drag** an object to a new location or select from a menu
- **Double click** on an object
- **Shift click** on an object

FOLLOW THESE STEPS:

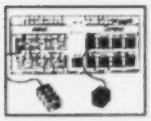
STEP 1: Follow your teacher's instructions to turn on the computer and load/start the Control Lab™ software.

STEP 2: Follow your teacher's instructions to insert the Control Mod disk into the computer.

STEP 3: Open the **File Menu** and select **Open Project** to open the **Open Project** dialog box.

- If you are using a **Macintosh®** computer, click **Desktop.** From the options that open, select **Control Mod.**

DAY 1 ACTIVITIES

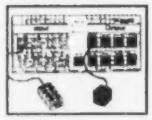


OBJECTIVES 1 AND 2

TOOLS AND MATERIALS

PROCEDURE

DAY 1
ACTIVITIES



- If you are using a **MS-DOS®** computer, click **Drives.** Then follow your teacher's instructions to select the drive that contains the Control Mod disk.

STEP 4: Select the file named **mcauto** to open a special utility program that will help you become familiar with the Control Lab™ serial interface.

STEP 5: Look at the picture of the interface box that is on your screen. Using the mouse, point and click on each of the parts of the interface box to open an information text box. Read the information in the text box to become familiar with the interface box before proceeding.

STEP 6: Check the interface box connected to your computer. The green light above the test port should be shining. If it isn't, have your teacher check the connections and turn the interface on.

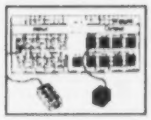
STEP 7: From the Control Lab™ Technology set (item #9701), take out the following parts:

- one motor
- one lamp
- one sound element
- one connecting lead with connecting plates at each end.

See page 12 in the Control Lab™ Setup Guide and Introductory Explorations book for pictures of these parts.

STEP 8: Look at one of the the connector plates at the end of the connecting lead. Find the small metal parts in the studs on top of the connector plates at the ends of the wires. Find the metal edges in the recessed bottom of the connector plate. These metal components provide a

See page 12 in the Control Lab™ Setup Guide and Introductory Explorations book.



pathway for the electricity so it can travel along the wires. This plate is called a 2x2 plate because it has two rows of two studs in each direction.

STEP 9: Examine the motor, lamp, and sound element. Find the metal components that provide an electrical path through each element.

☑**NOTE:** Neither the motor nor the sound element have metal parts in the studs on top.

STEP 10: Clip the bottom of one end of the connecting lead to the test port on the interface box. Let the wire hang down from the test port toward the bottom of the interface box.

See page 13 in the Control Lab™ Setup Guide and Introductory Explorations book.

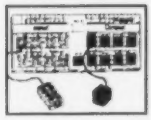
STEP 11: Clip the bottom of the sound element to the four studs on top of the connecting plate at other end of the connecting lead. Grasp the top of the sound element and turn it. Listen to the sound. Explore how to control the sound by turning the top of the sound element.

The sound element produces two different sounds, depending on the polarity of the electrical current flow. Turning the top of the sound element changes the direction of the electricity. The top has four positions. Two positions stop the flow of electricity and produce no sound. The other two positions produce two different sounds.

Does the sound element work if it is clipped onto only two of the four studs on the connecting plate? Be sure to turn the top of the sound element to all four positions.

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 1 ACTIVITIES



☑**NOTE:** The sound element will work if it is connected to the two studs nearest the wire or to the two studs farthest from the wire. However, it does not work if it is only connected to the two studs on the right or left sides because the studs on the sides are the same voltage. In order for electricity to flow a difference in voltage is needed.

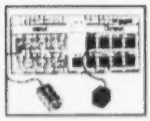
If the connecting plate is fastened to the studs on top of the sound element, is any sound produced? (No, because there are no metallic studs on top of the sound element.)

STEP 12: Replace the sound element with the lamp. Notice that the lamp lights up when it is clipped to the top or the bottom of the connecting plate. The base of the lamp can be clipped onto the top or bottom of the connecting plate. The lamp lights when connected to the two studs nearest the wire or to the two studs farthest from the wire.

See page 14 in the Control Lab™ Setup Guide and Introductory Explorations book.

STEP 13: Put the lamp aside and clip the motor to the connecting plate. The connecting plate must be clipped to the contact points on the bottom of the motor. When connected correctly the motor begins to run with a smooth humming sound.

Can you find any connections where the motor does not run? (The motor does not run if only two side studs from the connecting plate are inserted into the electrical contact points or if the studs from the connecting plate are inserted into any nonmetallic LEGO® element. Also the motor does not run if the



connecting plate is fastened to the top of the motor since there are no metallic parts there.)

STEP 14: Try to do the following:

- Connect both the sound element and the lamp to the end of the connecting plate to produce both light and sound.
- Connect the motor, the lamp, and the sound element so that all three are running at once?

STEP 15: Before quitting, find out from your teacher whether you should save your work. Exit the program by selecting **Quit** from the **File Menu**. When asked whether you want to save your work, follow your teacher's instructions.

☑**NOTE: The save default is Yes so be sure to change to No if your teacher says not to save. Do not save anything unless told to do so by your teacher.**

STEP 16: Turn off the computer by following your teacher's instructions. Please return the motor, lamp, sound element and leads to the #9701 building set. Return all other materials to their proper storage areas and clean up your work area.

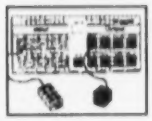
If you complete Day 1 Activities with time left over, you may begin Day 2 Activities.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

On Day 2 you should complete the following activities:

1. Complete Objective 3

DAY 2 ACTIVITIES



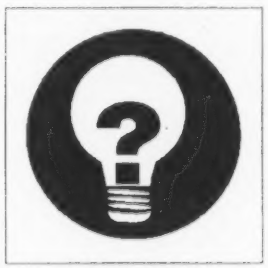
SUMMARY OF ACTIVITIES

Reading Comprehension

- React to written material

Functional Reading

- Follow written instructions
- Interpret graphics and symbols
- Use content area vocabulary



Creative Thinking and Problem Solving

- Create a finished product

TECHNOLOGY EDUCATION CONTROL ROBOTICS

Follow a sequential set of building plans to construct a vehicle that is powered and steered using two independent drive trains.

- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- Building Card 4 from the Control Lab™ Technology set (9701)

The dual drive system used to power the wheelchair model is very similar to the drive mechanism for a bulldozer. By controlling two drive wheels with independent motors, each wheel can operate independently of the other. By combining various combinations of forward and reverse directions, the vehicle can be made to go forward and backward, turn left or right, and rotate clockwise or counter-clockwise.

Hints to follow as you build:

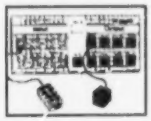
- You will need a flat building area that should be kept clear of all materials not directly involved in the building of this project.
- Locate the pieces as you build. Take out only the pieces you will need as you build.
- Building on a tray helps to keep the unassembled pieces together in one area.

FOLLOW THESE STEPS:

☑**NOTE:** For this day's activity, you will only build the wheelchair. You will build the joystick on another day.

STEP 1: Begin with the building instructions on page 4 of Building Card 4. Follow the step-by-step building instructions to complete the wheelchair model.

DAY 2 ACTIVITIES

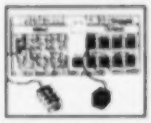


OBJECTIVE 3

TOOLS AND MATERIALS

INTRODUCTION

PROCEDURE



STEP 2: After the wheelchair is finished, test it by connecting each of the motor leads, one at a time, to the test port of the interface box.

STEP 3: Do not dismantle the model at the end of this activity. You will use it for several additional activities. At the end of the period, store your model together with the building set in the designated area. Return all other materials to their proper storage areas and clean up your work area.

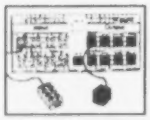
If you complete Day 2 Activities with time left over, you may begin Day 3 Activities.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

On Day 3 you should complete the following activities:

1. Complete Objective 4
2. Complete Objective 5
3. Complete Objective 6

DAY 3 ACTIVITIES



SUMMARY OF ACTIVITIES

Reading Comprehension

- Analyze cause and effect
- Draw conclusions
- Make generalizations

Functional Math

- Make measurements

Creative Thinking and Problem Solving

- Collect/record information
- Apply a problem-solving model
- Analyze/synthesize information
- Draw conclusions
- Apply intuitive thinking techniques

TECHNOLOGY EDUCATION CONTROL ROBOTICS

Control a model using three types of input.

Program your wheelchair to turn 90º and 180º.

Write the advantages and disadvantages of each type of control.

- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- Wheelchair built on Day 2
- Protractor and yardstick or meterstick

INTRODUCTION

As computers advance in sophistication and speed, there has been a similar advancement in the methods by which you can provide input to a computer. Not too many years ago, holes were punched into cards and then fed through a machine between electrical contacts. The holes would allow electrical contact between two points thus completing a particular circuit. The completed circuit would complete a specific task. It was a very slow process.

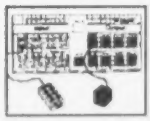
When keyboards were introduced as input devices they were much more convenient than cards. In fact, keyboards are still one of the most convenient ways to input information. But, there are other input methods, such as sensors, magnetic discs, joysticks, and laser disks, to communicate with the computer that are very easy and convenient. The easier a computer is to use, the more "user friendly" we say that it is.

PROCEDURE

FOLLOW THESE STEPS:

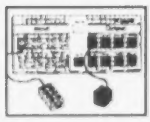
STEP 1: Follow Steps 1–3 from Day 1 (page 19) to turn on the computer and load the appropriate software.

DAY 3 ACTIVITIES



OBJECTIVES 4, 5, AND 6

TOOLS AND MATERIALS



STEP 2: Open the file named **control.** A picture of the Control Lab interface box opens on the screen. On the right side of the screen, you should see three icons. Each icon represents an output element. From top to bottom they are a

- motor icon
- lamp icon
- sound icon

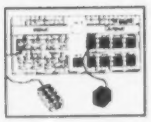
On the left side of the screen, you should see four icons that represent the input elements. From top to bottom they are:

- a temperature sensor
- a touch sensor
- a light sensor
- an angle sensor.

STEP 3: Hold the wheelchair in your hand with the front of the chair facing away from you. Connect one of the wheelchair's motor leads to the test port of the interface box. Is the right wheel turning? If it isn't, disconnect the motor lead and connect the other motor lead to the test port.

STEP 4: Is the right wheel turning clockwise? If it isn't, disconnect the motor lead, turn it 180º, and reconnect it. The right wheel should then turn clockwise.

STEP 5: Disconnect the motor lead from the test port and connect it to Output Port A on the interface box. Keep the lead pointing in the same direction. When connected, the wire should be facing the same direction as it did in the test port. Nothing should



happen—yet. The motor does not run when it is connected to Output Port A because no electrical power is available at Output Port A at the moment. The motor ran when it was connected to the test port because electrical power is always on in that port. Notice that the green indicator light for this port is always on.

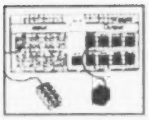
STEP 6: Select a motor icon with the mouse and drag it to Output Port A. The motor icon remains on Output Port A and the name of the motor changes to **motora.** The name **motora** simply means that Control Lab™ is expecting a motor to be connected to port A on the interface box. The motor connection you made on the screen corresponds to the actual motor connection you made with the connecting lead.

STEP 7: Using the mouse, point to one of the two small circles above the icon for output A on the Setup page. Press and hold the mouse button. The motor runs as long as you hold down the mouse button.

☑**NOTE:** A corresponding green light above Output Port A on the interface box lights up while the motor is running.

STEP 8: Holding the wheelchair in your hand, connect the wheelchair's other motor lead to the test port of the interface box. The wheelchair's left wheel should be turning counter clockwise. If it isn't, turn the motor lead 180° and reconnect it.

STEP 9: Connect this lead to Output Port B. Keep the motor lead facing the same direction when reconnecting. Drag a



motor icon to Output Port B. Using the two motors and the small circles above Output Ports A & B try to navigate the wheelchair around your work area. As long as you point to the correct spot on the screen and click on the mouse button, you can activate either motor. This system of control is known as point and click.

STEP 10: We can also use words to send commands to the devices we wish to control. In this case, the computer acts as an interrupter, taking the words we type into the computer and converting them to signals that will activate the interface box.

On the computer screen there is a long narrow window called the **Command Center.** To make the command center appear and disappear, do the following:

- **MAC:** Press the **APPLE key** and **D**
- **DOS:** Press **ALT D**

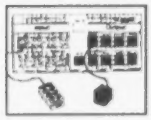
STEP 11: When the **Command Center** appears on your screen, click in its window and type the following exactly as it appears:

talkto "motora onfor 20

The line literally means talk to motor a and tell it to stay on for twenty tenths of a second. Twenty tenths of a second equals two seconds (20/10=2).

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 3 ACTIVITIES



STEP 12: When you have finished typing the line, press **RETURN**. If your wheelchair did not respond, retype the line exactly as it appears and be sure that

- there is a space between each word
- *talk* and *to* were typed as one word as one word—*talkto*
- *on* and *for* were typed as one word as one word—*onfor*
- *motor a* appears as one word—*motora*
- there is only one quotation mark in front of motora—*"motora*

STEP 13: Repeat the procedure to notice exactly how far the wheelchair turned when twenty was the time element.

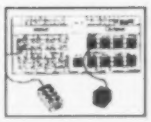
STEP 14: Use your protractor to measure out exactly 90º and 180º. Experiment changing the command you typed so that your wheelchair turns exactly 90º. You will have to change the time part of the command.

STEP 15: When your wheelchair turns 90º, write the time you used on a sheet of paper or in a notebook. You will use it later.

STEP 16: Now change the command so that your wheelchair turns exactly 180º. Record this time with the 90º time.

STEP 17: Demonstrate the 90º and 180º turns for your instructor.

DAY 3
ACTIVITIES



STEP 18: To make the wheelchair travel in a straight line, you have to talk to both motors at the same time. Click in the command center and type the following exactly as it appears:

talkto [motora motorb] SETLEFT onfor 40

The line literally means talk to motor a and motor b. Tell them both to stay on for forty tenths of a second.

STEP 19: When you have finished typing the line, press **RETURN.** The computer language we are using here is LOGO. As you can see, it is a shortened version of the way we talk.

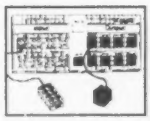
STEP 20: The LOGO language has special reserved words, called **primitives**, that we can use. **Onfor** and **talkto** are primitives. A list of primitives is found on pages 3.2–3.3 of the *LEGO DACTA® Control Lab™ Reference Guide*. Another primitive is **rd** meaning reverse direction. If we re-enter the command line and add rd, we get a difference result. Click in the command center and type the following exactly as it appears:

talkto [motora motorb] rd onfor 40

When you have finished typing the line, press **RETURN.**

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 3
ACTIVITIES



STEP 21: Using the commands you have learned, you will type a sequence of commands in the command center to make the wheelchair travel in a square pattern. Type the following exactly as it appears. Replace the **??** with the time you used to make the wheelchair turn 90º.

*repeat 4 [talkto [motora motorb] setleft onfor 15 talkto "motora onfor **??**]*

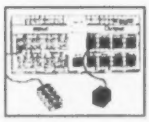
STEP 22: When you have finished typing the line, press **RETURN**.Hide the Command Center using **APPLE D** or **ALT D**.

STEP 23: Find the icon in the lower right corner that looks like a page being turned. Click on that icon to open a project page titled **Using Buttons.** On this page, there are six buttons. Drive the wheelchair by clicking on each of the direction buttons. What happens?

STEP 24: Click on the button labeled **Dance.**

STEP 25: Take a few minutes to drive the wheelchair around the work area using the buttons. Compare this button method with the point and click and typing commands methods. Which is easier? Write some advantages and disadvantages of each methods. You will turn this list in to your teacher.

STEP 26: As you can see a button is a convenient way to activate a series of instructions from the computer to the device being controlled. It is certainly a lot easier than typing every command, one at a time. No matter how many times you click on the **Dance** button the same



movements will be executed. This is a major advantage of controlling movement through a computer. Even though a computer is a processor, it also has a memory where it can store information. It can remember the series of instructions and carry out those instructions in the exact same way each and every time. The series of instructions placed in a computer is called a **program.**

STEP 27: Before quitting, find out from your teacher whether you should save your work. Exit the program by selecting **Quit** from the **File Menu**. When asked whether you want to save your work, follow your teacher's instructions.

☑**NOTE: The save default is Yes so be sure to change to No if your teacher says not to save. Do not save anything unless told to do so by your teacher.**

STEP 28: Turn off the computer by following your teacher's instructions. Store the assembled wheelchair for later use. Return all other materials to their proper storage areas and clean up your work area.

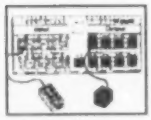
If you complete Day 3 Activities with time left over, you may begin Day 4 Activities.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

On Day 4 you should complete the following activities:

1. Complete Objective 7

DAY 4 ACTIVITIES



SUMMARY OF ACTIVITIES

Reading Comprehension

- Gain factual information
- Analyze cause and effect
- Draw conclusions
- Make generalizations
- React to written material

Functional Reading

- Use content area vocabulary

Creative Thinking and Problem Solving

- Collect/record information
- Analyze/synthesize information
- Draw conclusions
- Apply new technology
- Apply intuitive thinking techniques

TECHNOLOGY EDUCATION CONTROL ROBOTICS

Create a button to control the motion of a model.

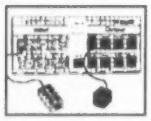
- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- Wheelchair built on Day 2

Keyboards used to be the only way to move a cursor around on a screen. Today many methods are available. Touch screens are one of the newer types of input devices. A touch screen is a special monitor in which the screen itself has sensors in it to detect pressure from a finger tip.

One of the most common uses of touch screens is to help people access information. For example, pretend you are in an unfamiliar city, and you want to know where to eat. In some places you might find yourself at an information desk looking at a computer screen with several choices listed. Touch the word **Food.** A new series of choices appears listing the various types of food. Touching the word **Pizza** displays the names and addresses of the various restaurants that serve pizza. Touch the name of one of the restaurants listed to see a map showing how to get from where you are to that restaurant. To make the choices easy to read, they are usually enclosed in a shaped box of some kind. These boxes reminded people of pushbuttons so the screen shapes became known as buttons.

On-screen buttons have become very popular in recent years as a way to make interaction between the computer and the user very easy. A mouse or a track ball also provides a fast way to get from one point on the screen to

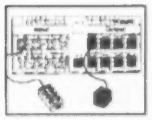
DAY 4 ACTIVITIES



OBJECTIVE 7

TOOLS AND MATERIALS

INTRODUCTION



another. With these devices, we can move the cursor to the buttons of our choice, then click to indicate our selection.Software programs like Control Lab™ allow the user to program the buttons.

PROCEDURE

FOLLOW THESE STEPS:

STEP 1: Follow Steps 1–3 from Day 1 (page 19) to turn on the computer and load the appropriate software.

STEP 2: Open the file named **button.**

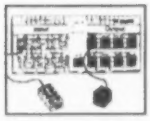
STEP 3: Connect the front motor lead of the wheelchair to Output Port A on the interface. Connect the other motor lead to Output Port B.

STEP 4: Click the button that looks like a switch to operate the wheelchair. Click again to stop the wheelchair. By pointing and clicking on the button, you make the computer perform a task. You can create buttons and have them at your disposal to perform any task or series of tasks.

STEP 5: To see how we created this button, do the following:

- Using the mouse, place the cursor over the button.
- Hold down the **SHIFT** key.
- Double-click the mouse. This will open a dialog box.

☑**NOTE:** If a dialog box did not appear, repeat the steps above. Be sure to hold down the **SHIFT** key while you're double-clicking. Be sure that the double click is in rapid succession.



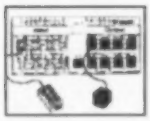
STEP 6: As you can see, there are several parts to the dialog box. The next activity explains the parts of the dialog box. Look again at the dialog box currently on the screen, then click on **OK.**

STEP 7: Click on the button in the lower right hand corner to turn the page to the next activity. This is a special utility page to help you become familiar with all the parts of the button dialog box. This dialog box is just a picture; it is not interactive (it doesn't make the motors and lamps operate). Use your mouse to click on various parts of the dialog box. A definition or description of the part will appear as text to the right.

STEP 8: Continue clicking until you are familiar with each of the parts. When you have finished, click the icon in the lower right hand corner and return to Project Page 2. You are to create two buttons and place them on this page beneath the existing ON/OFF button. One button will turn the wheelchair to the right. The other button will turn the wheelchair to the left.

STEP 9: To create a button from scratch, follow these steps.

- Click the button icon on the tools palette. (It is the second icon from the bottom.)
- Move to a vacant area on the page and click. A button labeled **button3** is created.



- Place the cursor inside **button3.** Hold down the **SHIFT** key and double-click the mouse to open the Button Dialog Box.
- Change the name of button from **button3** to **Turn Left.**
- Select a button icon shape called **Left** from the pop-up menu.

☑**NOTE:** Click on the default button shape and scroll up to select the word **Left.**

- Select the **ON** type button instead of the **ON/OFF** type button because you want this action to happen every time you click the button, not every other time.
- In the **ON Action Box** type the following:

  talkto "motora onfor 10

  This line means talk to motor A and tell it to turn on for 1 second (10 tenths)

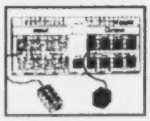
- Click on **OK.**

STEP 10: Now make the button for the wheelchair to turn in the opposite direction. Show your work to your instructor when you have the wheelchair turning in both directions.

STEP 11: Before quitting, find out from your teacher whether you should save your work. Exit the program by selecting **Quit** from the **File Menu**. When asked whether you want to save your work, follow your teacher's instructions.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 4 ACTIVITIES



☑**NOTE: The save default is Yes so be sure to change to No if your teacher says not to save. Do not save anything unless told to do so by your teacher.**

STEP 12: Turn off the computer by following your teacher's instructions. Check with your instructor to see whether to disassemble your model and return the parts to the building set or to store the assembled model for later use. Return all other materials to their proper storage areas and clean up your work area.

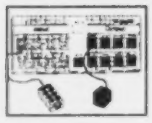
If you complete Day 4 Activities with time left over, you may begin Day 5 Activities.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

On Day 5 you should complete the following activities:

1. Complete Objective 8
2. Complete Objective 9
3. Complete Objective 10

DAY 5 ACTIVITIES



SUMMARY OF ACTIVITIES

Reading Comprehension

- Gain factual information
- Analyze cause and effect
- Draw conclusions
- Make generalizations
- React to written material

Functional Reading

- Use content area vocabulary

Creative Thinking and Problem Solving

- Collect/record information
- Define a problem
- Apply a problem-solving model
- Analyze/synthesize information
- Draw conclusions
- Devise a solution
- Create a finished product
- Apply intuitive thinking techniques
- Transfer knowledge/training to new situations
- Apply new technology

TECHNOLOGY EDUCATION CONTROL ROBOTICS

Describe the difference between primitives and procedures.

Name the parts of a procedure and explain what each part does.

Write a procedure to operate motors, lamps, or sound elements.

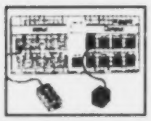
- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- Sound element, lamp, and 2 connecting leads

In previous activities you have used buttons and the keyboard entry of simple commands to control various outputs through the LEGO DACTA® interface. However, when there is a need to perform complex operations it is preferable to write a simple program or procedure to do these tasks. The procedure or program can be stored and recalled when needed

Various programming languages have been established to allow humans to communicate with computers. The language used in Control Lab™ is based on the LOGO programming language.

The commands in LOGO can be divided into two groups—primitives and procedures. Primitives are words that were assigned by the original programmers of Control Lab™. When you load the Control Lab™ program into your computer, these words are also loaded. Some of these words are used to communicate with the LEGO® motors, lights, and sound elements.

DAY 5 ACTIVITIES



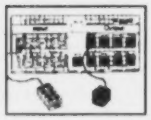
OBJECTIVES 8, 9, AND 10

TOOLS AND MATERIALS

INTRODUCTION

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 5 ACTIVITIES



If you wish to execute a series of commands, you can list the primitives that will carry out these commands and then assign a name to that list. This new name we assign to the list is known as a procedure.

The following is a quick analogy to help you with the differences.

Your friend has a dog named Seymor that he has to sell. You gladly take Seymor from your friend. Seymor knows how to sit, roll over and play dead. For example, if you say "sit", he immediately sits.

You decide that you are going to teach Seymor a new trick. Every time you say "Ugabuga" to him, he will immediately sit, roll over and play dead.

In this analogy, "sit," "roll over" and "play dead " are primitives; "Ugabuga" is be the name of the procedure.

The LOGO programming language is very easy to learn because the special commands are very "English like" and easy to understand. However, the LOGO language can be very complex. It requires you to think logically. LOGO, like any other language, has its own rules of grammar. These rules are called the syntax of the computer language.

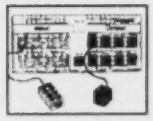
PROCEDURE

FOLLOW THESE STEPS:

STEP 1: Follow Steps 1–3 from Day 1 (page 19) to turn on the computer and load the appropriate software.

STEP 2: Open the file named **procd.**

STEP 3: Connect the sound element to Output Port F of the interface box. Connect the lamp to Output Port H. You will see an example of a procedure that makes two different noises with the sound element. This special utility page identifies the



parts of a procedure. Use your mouse to click on each of the parts of the procedure. A description of each part will appear.

STEP 4: When you have read about each part of a procedure, click the button at the top left hand corner of your screen. This button takes you to an actual procedures page.

STEP 5: This procedures page should have a rectangle at the bottom of the screen. Within the rectangle should appear the following message:

Welcome to LEGO DACTA® Control Lab™ software.

If that box is not there, do one of the following, depending on your computer.

- **MAC:** Press the **APPLE key** and **D**
- **DOS:** Press **ALT D**

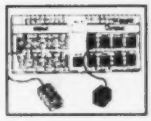
STEP 6: This box is named the **Command Center.** If we give the computer a command, it will be acted upon immediately.

- In the **Command Center,** type the following exactly as it appears:

  tto *"lamph*
  on

  ☑**NOTE:** Press **RETURN** or **ENTER** to type the second line.

The light connected to the interface box port H should be lit. If not, go back and repeat the above steps.



STEP 7: The letters **tto** are an abbreviation for a LOGO primitive **talkto**; the letters **lamph** indicate that a lamp is connected to port H. The primitive **on** means exactly what is says.

STEP 8: A pull-down **Help Menu,** found at the top of the screen, is available to help you learn about the software. To use, open the **Help Menu.** From the list that opens, select the area you want information about and open that item.

STEP 9: To learn about the primitive **tto,** follow these steps:

- Open the **Help Menu** if it is not already opened.
- From the list that opens, select **Primitives.** You may have to use the scroll bar.
- From the **Primitives** list, select **tto,** then click on the **Help** button to make a definition appear.

STEP 10: In the **Command Center** now type the following:

off

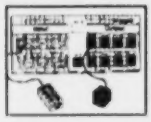
Press **RETURN** or **ENTER**

STEP 11: In the **Command Center** type the following. Be sure to type it exactly as it appears.

onfor 30

Press **RETURN** or **ENTER**

STEP 12: The primitive **onfor** tells the port to stay on for a certain period of time. The number stands for tenths of a second. Therefore 30 equals thirty tenths of a second or three seconds.



STEP 13: Use Help to find more information about **onfor.**

STEP 14: What you have on the screen is a procedure titled **sample.** In the **Command Center** type:

sample

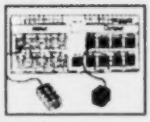
Press **RETURN** or **ENTER**

The procedure runs. Observe each action in the procedure.

STEP 15: Connect a sound element to Port F. Now it is your turn to write a procedure. You are to make the light come on, sound an alarm for 2½ seconds, turn the light off, wait 1 second, and sound a different alarm. Remember you can use the **Help Menu** to check out the proper syntax for your commands. Some suggested primitives you may want to use are: **off, on, onfor, talkto, tone,** and **wait.**

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 5 ACTIVITIES



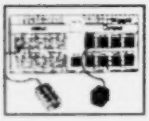
STEP 16: To write your own procedures, follow the steps below. If you need more information, see page 17 in the LEGO DACTA® Control Lab™ *Quick Start Guide*.

- Open the pull-down **Pages menu** and select **Procedures.** (This step is optional since you are already on the Procedures Page.)
- On a new line type the word *to* followed by a space, then the word *alarm*. **Alarm** is the name of the procedure you are writing.
- Type the commands necessary to accomplish your goal, Press **RETURN** or **ENTER** at the end of each line. When you are ready to have the sound element make a different tone, type the following command:

  tto "soundF rd

  ☑**NOTE:** Nothing will actually happen when you are typing the procedure. Think of it as making a shopping list. You make the list now, but you actually buy the merchandise when you go shopping.
- When you are completely finished writing your procedure, press **RETURN** or **ENTER** and type the word *end* on a line by itself. Then press **RETURN** or **ENTER** again. You have now written a procedure!

STEP 17: In order to see if your procedure does what it is supposed to do, type *alarm*, the name of your procedure,in the **Command Center.** Then press



RETURN or **ENTER.** If everything worked OK, you are finished this activity. If something is out of order, go back to your procedure and make the necessary changes before you finish.

STEP 18: Have your instructor check your work when the procedure is completed. You will also need to do the following things as you demonstrate the procedure:

- Identify each of the parts of your procedure and tell what it does.
- Discuss the differences between a primitive and a procedure

STEP 19: Follow your teacher's instructions to choose one of these options:

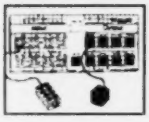
- print your Project Page
- store the Project Page for later use.
- continue without making a record of your work

STEP 20: The next activities will make use of the information you learned in this activity. Make sure you understand both primitives and procedures before you continue.

STEP 21: Before quitting, find out from your teacher whether you should save your work. Exit the program by selecting **Quit** from the **File Menu**. When asked whether you want to save your work, follow your teacher's instructions.

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 5 ACTIVITIES



☑**NOTE: The save default is Yes so be sure to change to No if your teacher says not to save. Do not save anything unless told to do so by your teacher.**

STEP 22: Turn off the computer by following your teacher's instructions. Store the assembled wheelchair for later use. Return all other materials to their proper storage areas and clean up your work area.

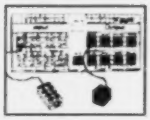
If you complete Day 5 Activities with time left over, you may begin Day 6 Activities.

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

On Day 6 you should complete the following activities:

1. Complete Objective 11
2. Complete Objective 12
3. Complete Objective 13
4. Complete Objective 14

DAY 6 ACTIVITIES



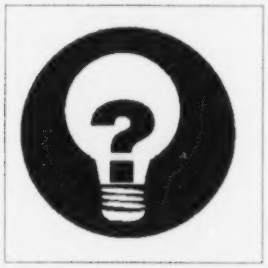
SUMMARY OF ACTIVITIES

Reading Comprehension

- Gain factual information
- Analyze cause and effect
- Draw conclusions
- Make generalizations
- React to written material

Functional Reading

- Use content area vocabulary

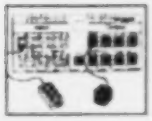


Creative Thinking and Problem Solving

- Collect/record information
- Define a problem
- Apply a problem-solving model
- Analyze/synthesize information
- Draw conclusions
- Devise a solution
- Create a finished product
- Apply intuitive thinking techniques
- Transfer knowledge/training to new situations
- Apply new technology

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 6 ACTIVITIES



OBJECTIVE 11

Demonstrate the use of variable versus binary inputs using input components from the LEGO DACTA® Control Lab™ building set.

TOOLS AND MATERIALS

- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- A touch sensor and a light sensor

INTRODUCTION

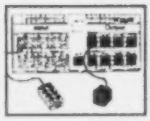
Computers reduce all information and data to two different modalities—**on** and **off.** Computer programmers use the base two number system to communicate with computers. In this system, the numeral 0 equals **off,** and the numeral 1 equals **on.** Since there are only two possibilities for electrical switches (on or off) this two-state input is usually referred to as binary or digital input.

Switches do a good job of turning things on and off, but you sometimes need a level between on and off. For example, if you are having a candlelight dinner, you might need to supplement the candle's light with dim electrical lights. If, however, you want to play a game or read at the same table, you would need more light. To get varying amounts of illumination from the same lamp, you must vary or change the voltage. If you use a light sensor to measure the amount of light produced by the lamps, you would see that the voltage provided by the sensor varies proportionately with the light intensity. A continuously varying voltage that affects the action of a processor is called an analog input.

Digital inputs such as on/off have only two possible values, while analog inputs have constantly varying values.

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 6 ACTIVITIES



PROCEDURE

FOLLOW THESE STEPS:

STEP 1: Follow Steps 1–3 from Day 1 (page 19) to turn on the computer and load the appropriate software.

STEP 2: Connect the lead from the touch sensor to Input Port 1. Connect the light sensor to Input Port 7. Open the project file named **dvsa.**

STEP 3: A picture of the Control Lab™ interface box will be on the screen. Input Port 1 should have a touch sensor in place. Input Port 7 should have a light sensor in place. The icons on the Setup page should now be the same as the sensors that are connected to the interface box. If they aren't the same, make the necessary corrections.

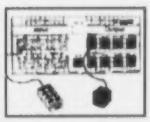
STEP 4: From the **Pages Menu** select **Page 1.** Two Control Lab™ monitor boxes and some written instructions will open. Follow the instructions on the screen. Using the Control Lab™ system, you can have the computer display values from both digital inputs and analog inputs on special monitor boxes on the computer display screen. These values can also be used to control other special elements connected to output ports.

STEP 5: Your next activity will make use of the information you learned in this activity. Make sure you understand both digital inputs and analog inputs before you continue.

Continue Day 6 Activities by completing Objectives 12 and 13.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 6 ACTIVITIES



OBJECTIVES 12 and 13

Construct monitor boxes to display input values.

Control the speed and direction of a motor-driven LEGO model by using feedback from a Control Lab™ angle sensor and touch switch.

TOOLS AND MATERIALS

- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- Wheelchair from earlier activities
- A touch sensor and an angle sensor
- An axle at least 4 studs long and 1 or 2 wheels

INTRODUCTION

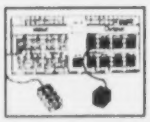
Robotics devices that operate in the real world rely on feedback from input sensors to cause changes in the output devices. Just as the speed of a gasoline-powered automobiles are controlled by the gas pedal that controls how much fuel gets to the engine, the speed of electric motors can be controlled by the value of an input sensor.

When humans interact with machines, the human needs to monitor what the machine is doing. For example, when someone drives a car, a series of sensors report speed, oil pressure, water temperature and fuel level to the driver. These values are reported in a variety of ways to the driver's instrument panel.

The Control Lab™ primitive SETPOWER sets the power of our output devices in a range from zero (off) to eight (full speed). In this activity, you will use the monitor panels to determine the values of the minimum and maximum speed of the Control Lab™ wheelchair.

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 6
ACTIVITIES



PROCEDURE

FOLLOW THESE STEPS:

STEP 1: Connect the lead from the wheelchair's front motor to Output Port A. Connect the lead from the other motor to Output Port B. If your computer is on and has the Control Lab™software loaded, go to step 3. If the computer isn't ready to load a project, go to Step 2.

STEP 2: Follow Steps 1–3 from Day 1 (page 19) to turn on the computer and load the appropriate software.

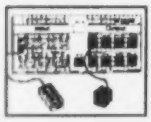
STEP 3: Open the project file named **inputs.**

STEP 4: The Control Lab™ interface box pictured on the setup page should show a touch sensor icon on Input Port 1, an angle sensor on Input Port 8, and a motor icon on Output Ports A and B. The icons on the setup page should now be the same as the sensors that are connected to the interface box. If there are any differences, please correct them before continuing.

STEP 5: From the **Pages Menu** select **Page1.** Several Control Lab™ buttons in the **Chair Control Center,** a touch sensor monitor box, and plenty of open space for you to create an additional monitor box are now on the screen.

STEP 6: You are going to create your own monitor panel for angle sensor 8. Click on the monitor tool box (shows 21º on the icon) on the tools palette. The cursor changes to a crosshairs shape.

DAY 6
ACTIVITIES



STEP 7: Move the crosshairs cursor to an open space on the page, then click and drag to form a rectangular monitor box.

STEP 8: Point to the center of the monitor box and shift-double-click to open the **Modify Monitor dialog box.** The **Name box** should already be highlighted. Name the monitor box by changing the existing name to one you choose. We suggest a name that refers to what you are going to monitor, such as **angle eight.**

STEP 9: Check to make certain the following boxes all are marked with an **X**:

- Show Name
- Show Frame
- Monitor: Active

STEP 10: Click to open the **f(x) icon** in the **Show: Box** and select **Angle 8** from the options available. Click **OK** or simply press **RETURN** or **ENTER.**

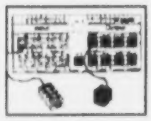
STEP 11: In the **Chair Controls** section of the computer screen click on the **On** button to begin.

STEP 12: For the wheelchair to move, the touch sensor must be depressed. Press the touch sensor to see the chair move. Let go of the touch sensor to have the chair stop. Repeat this operation several times to see how the digital input controls the on/off action of the chair.

☑**NOTE:** You can click the **Off** button in the **Chair Controls** section at any time to stop the control procedure. To restart, click on the **On** button.

TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 6
ACTIVITIES



STEP 13: Using the wheel on the angle sensor, rotate the wheel forward and backward, while observing the changing numbers in the monitor box you created.

STEP 14: Rotate the wheel until your monitor shows the numeral **2,** then click on the **Set Power button** in the **Chair Controls** section of the computer screen. Observe what happens to the power level. Using the touch sensor, start and stop the chair several times at this power level.

STEP 15: Using the method you just learned, set various power levels and activate the chair to determine the minimum and maximum power levels at which the chair will move. Record your results.

Minimum power level _____

Maximum power level _____

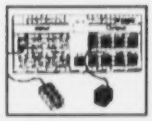
STEP 16: Continue to explore the operation of the analog and digital control functions to move the chair forward and backward at varying speeds. When you are satisfied that you understand how this function works, click the **Off button** in the **Chair Control** section to stop the control program.

STEP 17: Follow your teacher's instructions to choose one of these options:

- print your Project Page
- store the Project Page for later use.
- continue without making a record of your work

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 6 ACTIVITIES



STEP 18: Before quitting, find out from your teacher whether you should save your work. Exit the program by selecting **Quit** from the **File Menu**. When asked whether you want to save your work, follow your teacher's instructions.

☑**NOTE: The save default is Yes so be sure to change to No if your teacher says not to save. Do not save anything unless told to do so by your teacher.**

STEP 19: Turn off the computer by following your teacher's instructions. Store the assembled wheelchair for later use. Return all other materials to their proper storage areas and clean up your work area.

Continue Day 6 Activities by completing Objective 14.

OBJECTIVE 14

Follow a sequential set of building plans to construct a joystick that makes use of angle sensors.

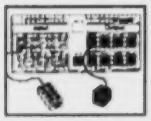
TOOLS AND MATERIALS

- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- Building Card 4 from the Control Lab™ Technology set (9701)

INTRODUCTION

When developers began designing new computer input devices, many devices used in mechanical control systems were modified to work with the newer electronic input systems. One example of this modification is the input device called a joystick. Depending on the

DAY 6 ACTIVITIES



location of the joystick handle, this device allows variable resistors called potentiometers to send different output voltages to an electronic interface relay, which in turn controls output motors.

The term user friendly refers to how easy it is for a nontechnical person to use. To make computers more user friendly, it is necessary to make input devices easier to use and understand. For example, it is easier to give voice commands than to type the command on a keyboard. It is easier to play a computer game with a joystick than it is to play from the keyboard. Joysticks come in many shapes and sizes. A joystick is a useful,convenient input device that is used for everything from computer games to jet controls.

PROCEDURE

FOLLOW THESE STEPS:

STEP 1: You have already built the wheelchair so you will only need to construct the joystick now. Begin building on page 1 of building instructions 9701-4.

STEP 2: Do not dismantle either model at the end of the period. They will be used for several additional activities.

STEP 3: At the end of the period, store your models together with the building set in the designated area. Clean up your area.

STEP 4: If you haven't already turned off the computer, turn it off following your teacher's instructions. Return all other materials to their proper storage areas and clean up your work area.

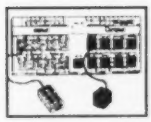
If you complete Day 6 Activities with time left over, you may begin Day 7 Activities.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

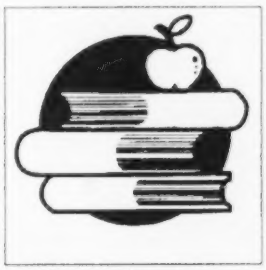
On Day 7 you should complete the following activities:

1. Complete Objective 15

DAY 7 ACTIVITIES



SUMMARY OF ACTIVITIES

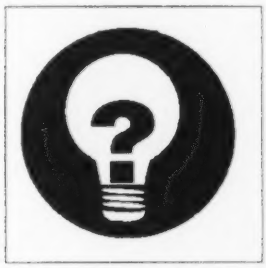


Reading Comprehension

- Gain factual information
- Analyze cause and effect
- Draw conclusions
- Make generalizations
- React to written material

Functional Reading

- Use content area vocabulary



Creative Thinking and Problem Solving

- Collect/record information
- Define a problem
- Apply a problem-solving model
- Analyze/synthesize information
- Draw conclusions
- Devise a solution
- Create a finished product
- Apply intuitive thinking techniques
- Transfer knowledge/training to new situations
- Apply new technology

TECHNOLOGY EDUCATION CONTROL ROBOTICS

Observe the input and resulting output of a joystick operated device.

- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- The joystick and wheelchair from earlier activities

You will be applying information from the previous activities. If you don't understand something, review a previous activity

When developers began designing computer input devices, the joystick from an airplane cockpit was modified for computer use. Because it could control variable value inputs for two directions, this device became the popular choice for moving the computer curser around the computer screen.

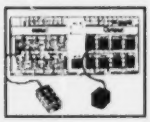
The joystick became popular along with electronic video games. Most of these games used a joystick as an input control. The joystick, once found only in airplane cockpits, was suddenly found in living rooms all around the world.

When robotic devices entered into the toy market, the joystick proved to be an effective and relatively inexpensive input control device. The joystick was capable of controlling up to two different but related outputs at the same time. The joystick controls variable value inputs along along both an x-axis and a y-axis).

FOLLOW THESE STEPS:

STEP 1: Using the wheelchair and joystick you already built, today you will connect your models to the interface box and use the existing programs.

DAY 7
ACTIVITIES

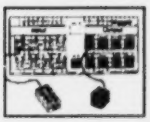


OBJECTIVE 15

TOOLS AND MATERIALS

INTRODUCTION

PROCEDURE



STEP 2: Connect the motors of the wheelchair model to Output Ports A and B on the interface box.

STEP 3: Connect the angle sensors of the joystick model to the interface box. The sensor between the handle of the joystick model should be connected to Input Port 5 and the sensor on the side of the base should be connected to Input Port 6. The sensor to Input Port 5 controls forward or backward movement. The sensor to Input Port 6 controls left or right movement.

STEP 4: Follow Steps 1–3 from Day 1 (page 19) to turn on the computer and load the appropriate software.

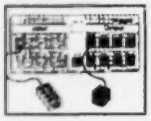
STEP 5: Open the file named **joystk.**

STEP 6: The picture of the Control Lab™ interface box should show Input Ports 5 and 6 with a angle sensor in place and Output ports A and B with motors in place. The icons on the Setup page should now be the same as the sensors and motors that are connected to the interface box. Click on the dots above the motor icons to ensure that the wheelchair motors are connected and working properly. For this activity, you will only need to connect your models to the interface box and use the existing program.

STEP 7: To open the **Joystick Control page** click the icon in the lower right hand corner of your screen. Several buttons and monitors appear on the screen. The monitors may or may not be showing a number.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 7 ACTIVITIES



STEP 8: Make sure your joystick is in the center (neutral/home) of the motion range of both sensors because when you start the control program, the position of the neutral/home position will be set wherever the joystick control is located at that time.

STEP 9: Click on the **Go button** to operate the wheelchair control program. Move the joystick forward slowly and observe the wheelchair model. Then move the joystick back to the **home position.** Experiment with the joystick until you can control the wheelchair successfully.

STEP 10: Click on the **Stop button** to exit the wheelchair control program.

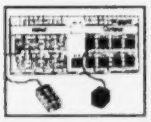
STEP 11: Before quitting, find out from your teacher whether you should save your work. Exit the program by selecting **Quit** from the **File Menu**. When asked whether you want to save your work, follow your teacher's instructions.

☑**NOTE: The save default is Yes so be sure to change to No if your teacher says not to save. Do not save anything unless told to do so by your teacher.**

STEP 12: Turn off the computer by following your teacher's instructions. Store the assembled wheelchair for later use. Return all other materials to their proper storage areas and clean up your work area.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 7 ACTIVITIES



If you finish early, complete one or both optional activities.

Optional Activity 1

STEP 1: Set the handle of the joystick all the way to the bottom and to one side.

STEP 2: Click on the **Go button** to operate the wheel chair control program.

STEP 3: Move the joystick and observe the wheelchair model. Can you successfully control the wheelchair with the joystick with this new home position? No, because it is impossible to get the + and - range necessary to make the motors run in the opposite direction.

STEP 4: Click on the **STOP button** to exit the wheel chair control program.

Optional Activity 2

Bulldozers aren't operated by a joystick. They are actually operated by two independent levers. One lever to control the power and direction of the left track, and one lever to control the direction and power of the right track.

Build a device to replace the joystick that has two independent controls—one for the left motor and one for the right motor.

Write a new procedure that will take input from your new controller to operate the wheelchair?

Which device gave you more control?

Which device was easier to manipulate?

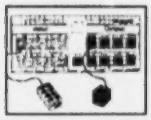
If you complete Day 7 Activities with time left over, you may begin Day 8 Activities.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

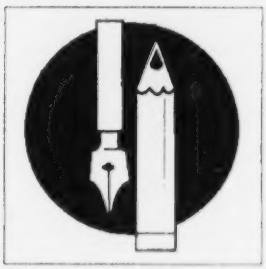
On Day 8 you should complete the following activities:

1. Read Impact Statements
2. Complete Career Search Activity
3. Complete any unfinished assignments
4. Complete Posttest

DAY 8 ACTIVITIES



SUMMARY OF ACTIVITIES



Language

- Use standard grammar, spelling, and capitalization
- State ideas clearly

Functional Writing

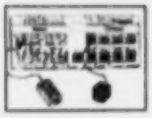
- Use computer graphics

Job Search/ Selection

- Analyze personal occupational aptitudes/preferences
- Investigate employment prospects of a career field/occupation
- Investigate training requirements for a career field/occupation
- Investigate benefits of a career field/occupation

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 8 ACTIVITIES



ENVIRONMENTAL IMPACT

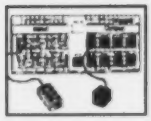
Control technology and robotics has many effects on the environment. These new technologies often reduce waste and use raw materials more efficiently than older manufacturing methods. These technologies also make it possible to clean up, maintain, or explore the environment in areas where humans can not safely go.

SOCIAL IMPACT

Control technology and robotics has numerous social implications. Because these new technologies can perform many of the boring and repetitive tasks involved in manufacturing, there will be opportunities for employees to have more interesting jobs. Although the new technologies sometimes take away jobs, new ones are usually created providing new opportunities for employment. These new jobs usually require new training for the employees. Learning new skills usually make these people more employable. These new technologies can also do some of the dangerous jobs that in the past exposed employees to injury or death.

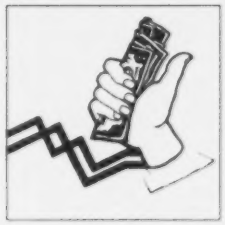
TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 8 ACTIVITIES



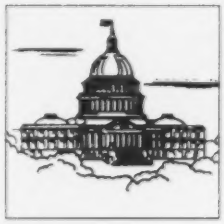
ECONOMIC IMPACT

Control technology and robotics has impacted the economy in numerous ways. These technologies make it possible to produce goods more efficiently by reducing wastes, speeding up the process, and making the process more error-free. These things, in turn, make the process more flexible and allow new and different products to be produced. Retooling for new products used to be an expensive and time-consuming process that included many hours or days of down time. Now retooling is often as simple as reprogramming a computer.



POLITICAL IMPACT

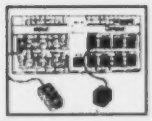
Control technology and robotics also affects several political issues. Unemployment and retraining of employees are always hot political topics. Implementing these technologies in the workplace usually causes some elimination of jobs, which in turn, either causes workers to be unemployed or makes retraining for new jobs necessary. The new technologies should also cause a change in the education system so that new workers are trained for the new jobs instead of for the out-of-date ones.



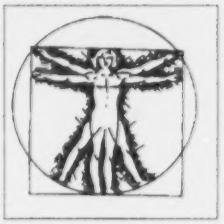
TECHNOLOGY EDUCATION CONTROL ROBOTICS

Control technology and robotics has an ergonomic effect on each of us because these new technologies usually make our lives easier and better. Electric eyes that open and close doors, automated checkout systems, traffic lights activated by waiting cars, and appliances that shut off or on automatically are a few examples of how these technologies are changing the way we live.

DAY 1 ACTIVITIES

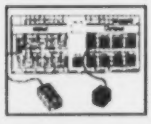


ERGONOMIC IMPACT



TECHNOLOGY EDUCATION
CONTROL ROBOTICS

DAY 8
ACTIVITIES

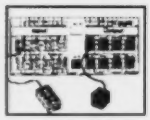


CAREER SEARCH ACTIVITY
INSTRUCTIONS

Using Career Search Abstracts, find the occupations listed below. Select the two occupations that sound most appealing to you. On a separate sheet of notebook paper, list the two occupations you selected and tell why. Remember to use complete sentences, proper grammar, and correct spelling. Give the sheets to your instructor.

- Electrical and Electronics Engineer
- Electromechanical Equipment Assembler
- Numerical Control Machine Tool Operator
- Numerical Control Tool Programmer
- Robotics Technician

RELATED CAREERS



ELECTRICAL/ELECTRONICS ENGINEER

NATURE OF THE OCCUPATION

Electrical and electronics engineers conduct research and development activities in relation to the design, manufacture, testing and application of electrical and electronic components, products and systems.

Duties may include but are not limited to the following:

- Designing test apparatus
- Devising evaluation procedures
- Developing new and improved products
- Recommending equipment design changes
- Writing equipment specifications
- Writing performance requirements
- Directing field operations
- Developing maintenance schedules
- Solving operational problems

OCCUPATIONAL SPECIALTIES

Electrical (003.061-026) and **Electronics Research Engineers** (003.061-038) conduct research in various areas of electrical and electronic applications.

Illuminating Engineers (003.061-046) design and direct installation of illuminating equipment and systems for buildings, plants, streets and other facilities.

Power System Electrical Engineers (003.167-018) design power system facilities and equipment and coordinate the construction, operation and maintenance of electric power generating, receiving and distribution stations, systems and equipment.

WORKING CONDITIONS

Electrical and electronics engineers usually work with other engineers, technicians and construction or manufacturing workers. They may work as part of a specialist team or supervise construction of factory workers.

Electrical and electronics engineers usually work in well-lighted and well-ventilated offices or laboratories. Others work in factories, power installations or out-of-doors. Electrical and electronics engineers may be required to relocate to work on different projects. Long-term projects may last 2 or 3 years.

Electrical and electronics engineers may join professional organizations such as the National Society of Professional Engineers or the Institute of Electrical and Electronics Engineers. Members pay annual dues.

You should like:

- Activities that are scientific and technical in nature
- Activities dealing with things and objects
- Activities relating to processes, machines and methods

You should be able to:

- Understand and use high-level mathematics
- Recognize differences in the size, shape and form of objects, lines and figures
- Work carefully and pay close attention to details
- Think logically
- Analyze and solve problems based on accurate information
- Make decisions
- Direct, control and plan activities
- Communicate effectively with others

Physically you must:

- Work with your hands and fingers
- See well, either naturally or with correction, including color vision
- Talk and hear

Special Requirements:

A Ph.D. degree is required for teaching in a college or university and is usually required for research positions in industry. Electrical and electronics engineers who have primary responsibilities for a project generally are required to be licensed.

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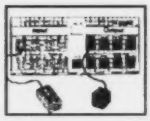


ELECTRICAL/ELECTRONICS ENGINEER

Opportunities for Experience:

Scientific and technical hobbies may provide helpful experience in this area. Summer employment in electronics businesses and co-op programs in college offer excellent opportunities for experience. Opportunities are also available through branches of the military service.

Methods for Entry:

Methods of entering this occupation include direct application to employers and civil service exams. Positions may also be located by consulting newspaper want ads, professional publications, college placement offices and state employment offices.

EARNINGS AND ADVANCEMENT

Earnings depend upon the type, size and location of the employing organization and the employee's education, experience, capabilities and responsibilities.

Earnings:

In 1994, beginning electrical engineers with bachelor's degrees earned average salaries of $33,872. Those with master's degrees had beginning salaries averaging $40,578; and those with Ph.D. degrees earned salaries averaging $57,283. The average annual salary for all electrical engineers in 1994 was $50,709, or $975 per week.

Oklahoma Salary:

Region	Range
Central	22.00-26.00
Northeast	14.00-23.00
Northwest	12.00-23.00
Southwest	--
Southeast	18.00-20.00

Fringe Benefits:

Depending on the employer, electrical and electronics engineers may receive paid vacations and holidays, paid sick leave, life, health, accident and disability insurance, and retirement plans. These benefits are usually paid for, at least in part, by the employer. Some employers may also provide educational reimbursements.

Career ladder for this occupation may look like this:

- Chief Engineer - Manager
- Electrical and Electronics Engineer
- Electrical and Electronics Engineer Trainee

EMPLOYMENT AND OUTLOOK

There were approximately 370,000 electrical and electronics engineers employed nationally in 1992. Employment is expected to be good through the year 2005 due to the growing demand for computers, communications equipment, military electronics, and electrical and electronic consumer goods.

Electronic engineers who fail to keep up with the rapid changes in technology in some specialties risk technological obsolescence, which makes them more susceptible to layoffs or, at a minimum, likely to be passed over for advancement.

Oklahoma Employment and Outlook

In Oklahoma, electric and electronics engineers are projected to have 115 job openings annually until the year 2000. These job openings represent new job growth and replacements caused by leaving the occupation, promotions, retirements, etc. In 1990, electric and electronics engineers held 2,718 jobs in Oklahoma. They are expected to hold 3,316 jobs by the year 2000. This is considered an average growth rate.

Levels of education and training usually needed for this occupation:

- College - bachelor's degree
- College - master's degree

School subjects helpful in preparing for this occupation:

- College Preparatory
- Composition
- English
- Algebra
- Calculus
- Geometry
- Trigonometry
- Chemistry
- Physics
- Humanities
- Cooperative Education - Trade and Industrial Drafting
- Machine Shop
- Electricity and Electronics

MORE SOURCES OF INFORMATION

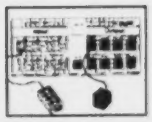
- National Action Council for Minorities in Engineering
  3 West 35th Street
  New York, NY 10001

- Institute of Electrical and Electronics Engineers (IEEE)
  345 E. 47th Street
  New York, NY 10017

- Society of Women Engineers (SWE)
  120 Wall Street 11th Floor
  New York, NY 10017

- JETS-Guidance
  1420 King St., Suite 405
  Alexandria, VA 22314-2715

- National Engineering Consortium
  303 E. Wacker Dr., Suite 740
  Chicago, IL 60601



ELECTROMECHANICAL EQUIPMENT ASSEMBLER

NATURE OF THE OCCUPATION

Electromechanical equipment assemblers build, prepare and test equipment or devices such as dynamometers, ejection seat mechanisms, magnetic drums and tape drives that contain electronic sensing devices that monitor, control, or activate mechanical operations.

Duties may include but are not limited to the following:

- Reading blueprints or written instructions
- Examining parts for surface defects
- Positioning parts needed to assemble equipment
- Fastening parts together, using hand tools
- Soldering electrical components in place
- Testing the electrical and mechanical reliability of assemblies, using a multimeter, oscilloscope, oscillator, gauges, test lights, or other tools
- Drilling, reaming, or tapping holes when needed to complete the assembly of equipment

OCCUPATIONAL SPECIALTIES

Final Assemblers (706.381-018) assemble, install and adjust such electromechanical units as feed drivers, control key assemblies, and printing units, on new and rebuilt punch card office machines.

Electromechanical Technicians (710.281-018) fabricate, test, analyze, and adjust precision electromechanical instruments, such as temperature probes, gyroscope units, telemetering systems, altimeters, and aerodynamic probes.

Electromechanical Assemblers (828.381-018) assemble and test and repair precision electromechanical parts such as gyros, servomechanisms, electronic instruments, radar and missile controls.

WORKING CONDITIONS

Electromechanical equipment assemblers usually work alone, under general supervision; however, some work in teams. Electromechanical technicians work in manufacturing plants or branch facilities, although many install, repair, and maintain equipment at customer facilities.

Although electromechanical equipment assemblers usually work 8 hours a day, 5 days a week, their schedules may vary. Large plants may have more than one shift. Overtime may be necessary to meet production or customer deadlines.

Tools, equipment and materials used may include:

- Blueprints and written specs.
- Torque wrenches
- Soldering tools
- Templates
- Test lights
- Hand tools
- Power bench tools
- Work tables
- Grinders
- Drill presses
- Fixtures
- Punch presses
- Binocular microscopes
- Atmosphere test chambers
- Micrometers, verniers, calipers and height gauges

You should like:

- Working with your hands to make and assemble things
- Doing work involving machines, processes, or methods
- Work that produces tangible results

You should be able to:

- Interpret detailed specifications and instructions and apply independent judgment
- Visualize flat drawings or pictures with three dimensions
- See detail in objects or drawings and recognize slight differences in shapes or shadings
- Work skillfully with your hands
- Rate information using standards that can be verified
- Work within precise limits or standards of accuracy
- Perform a variety of tasks that may change often

Physically you must:

- Stoop, kneel, crouch, and crawl
- Reach for objects and handle them skillfully
- See well, either naturally or with correction, to follow diagrams and color codes

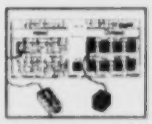
Special Requirements:

Employees seek workers who can do routine, uncomplicated, and sometimes repetitive tasks while remaining motivated. Some electromechanical equipment assemblers use heavy press machinery and therefore must be 18 years old or older. Some employers prefer to hire electromechanical equipment assemblers who have associate degrees with a specialty in electronics or mechanical technology or equivalent military training.

Opportunities for Experience:

Secondary vocational education programs in business and vending machine repair and post-secondary programs in electrical and electronics technology may offer co-op opportunities for practical experience.

Students may find a summer or part-time job in manufacturing facilities employing assemblers. Student membership in the Instrument Society of America's (ISA) student sections, located at many technical institutions, is helpful. Experience in electronics or electromechanical technology may be obtained through a formal apprenticeship.



ELECTROMECHANICAL EQUIPMENT ASSEMBLER

Methods for Entry:

The most common method of entry is direct application to employers. Graduates of technical institutes or colleges may find a job through their school placement office. Assistance in finding a job may be available through state agency offices and local unions.

Openings are listed in newspaper want ads. In addition, *Instrumentation Technology*, the monthly publication of the Instrument Society of America, lists open positions.

EARNINGS AND ADVANCEMENT

Earnings of electromechanical equipment assemblers vary according to the skill level needed in the assembly process, the type of product assembled, the size and location of the plant, and extent of unionization.

Earnings:

Average earnings for all assemblers working full-time in 1994 was about $396 a week or $20,569 annually. Wage rates for precision assemblers working under union contracts ranged from about $13.15 to $20.90 an hour in 1994. Beginners earned wages around the lower rate, and after two years earned up to $17.50 an hour. Certain aircraft and other highly skilled assemblers earned $20.90 an hour or more. Some assemblers are paid incentive or piecework rates and can earn more by working faster.

Fringe Benefits:

Depending on the employer, electromechanical equipment assemblers may receive paid vacations and holidays, life, accident disability, health, dental and optical insurance, sick pay, tuition reimbursement and retirement plans.

Career ladder for this occupation may look like this:

- Electromechanical Equipment Supervisor or Sales Representative
- Electromechanical Equipment Assembler
- Trainee or Apprentice

Opportunities for advancement in electromechanical equipment assembly work are good, especially for the assembler with strong skills and extra training in electronics.

EMPLOYMENT AND OUTLOOK

Nationally, there were about 150,000 electromechanical equipment assemblers employed in 1992. Employment is expected to decline through the year 2005 due to increased automation and the transfer of companies to countries with cheaper labor. Most job openings will result as workers transfer to other jobs or leave the labor force.

Oklahoma Employment and Outlook

In Oklahoma, 3 job openings are projected annually for electromechanical equipment assemblers until the year 2000. However, all these job openings represent vacancies caused by leaving the occupation, promotions, retirements, etc., not new job growth. In 1990, electromechanical equipment assemblers held 364 jobs in Oklahoma. They are projected to hold 322 by the year 2000. This is a decline in the growth rate.

Levels of education and training usually needed for this occupation:

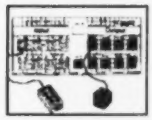
- On-the-job training
- High school diploma or G.E.D.
- High school diploma with vocational education

School subjects helpful in preparing for this occupation:

- Blueprint Reading
- Cooperative Education - Trade and Industrial
- Electricity and Electronics
- Shop Math
- Metal Shop
- Welding
- Shop Mechanics

MORE SOURCES OF INFORMATION

- Information is available from local offices of your state employment service and from locals of the unions.



NUMERICAL CONTROL MACHINE-TOOL OPERATOR

NATURE OF THE OCCUPATION

Numerical control tool operators set up and operate single or multi-purpose numerical control machines to perform such machining operations, as milling, drilling, reaming or broaching on metal workpieces, according to specifications. The controller directs the mechanisms of machine tools through the positioning and machining described in the computer programs for each job performed.

Duties may include but are not limited to the following:

- Review set-up sheet and specifications to determine operational sequences
- Bolt fixtures to machine bed
- Position metal stock in fixture, and secure workpiece
- Assemble cutting tools in tool holders, and position tools in spindles

OCCUPATIONAL SPECIALTIES

Numerical Control Router Set-Up Operators (605.360-010) set up and operate multiaxis, numerically controlled routing machines to cut and shape metallic and nonmetallic workpieces.

Numerical Control Milling-Machine Operators (605.380-010) set up and operate multiaxis, numerically controlled milling machines to mill surfaces on metallic and nonmetallic workpieces.

Numerical Control Drill-Press Operators (606.362-010) set up and operate numerically controlled drill presses that automatically perform machining operations such as drilling, reaming, countersinking, spotfacing and tapping of holes in metal workpieces.

Numerical Control Jig-Boring Machine Operators (606.382-014) set up and operate numerically controlled jig-boring machines to perform such jigging operations as boring, drilling and countersinking holes in metal workpieces.

WORKING CONDITIONS

Numerical control machine tool operators work in machine shops or the production department or tool room of factories. They work under the direction of supervisors or section leaders. They must stand most of the work day and may have to lift moderately heavy workpieces.

Most metalworking machine operators work a 5-day, 40-hour week. Some workers are employed on afternoon and night shifts. Overtime may be necessary at times to meet production requirements or contract deadlines.

Tools, equipment and materials used may include:

- Precision gauges
- Programmed tape or punched cards
- Dial indicator
- Machinists' tools
- Micrometer
- Set-up instructions
- Calipers
- Engineering drawings
- Blueprints
- Process sheets
- Templates
- Blocks, clamps, cams, stops
- Job orders

You should like:

- Activities dealing with objects
- Activities that involve the use of machines, processes or methods

You should be able to:

- Make decisions using standards that can be measured or checked
- Work within precise limits or standards of accuracy
- Look at flat drawings or pictures and understand how they would look as solid objects with height, width and depth
- See details in objects or drawings and recognize slight differences in shapes or shadings
- Work easily and skillfully with your hands

Physically you must:

- Lift objects weighing up to 50 pounds, with frequent lifting and carrying of objects weighing no more than 25 pounds
- See well, either naturally or with correction
- Use your hands and arms to reach, handle and manipulate objects
- Coordinate the use of your eyes and hands or fingers rapidly and accurately to perform a task

Special Requirements:

Because these are not entry-level occupations, employers prefer to promote machine tool operators or hire those with technical school training with courses in shop math, plane geometry and blueprint reading. If the operator is expected to write programs, the operator must attend a 1- to 2-week programming course offered by machine-tool manufacturers or technical schools. Even though numerically controlled machines require less skill to operate than other machine tools, many employers prefer numerical control operators to be skilled machinists so they can detect errors in the machine process.

Opportunities for Experience:

Secondary vocational education programs in machine tool operation and machine shop, and post-secondary programs in numerical control technology or robotics technology may offer opportunities for experience. Summer or part-time employment in unskilled

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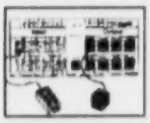


NUMERICAL CONTROL MACHINE-TOOL OPERATOR

positions may be available in some machine shops for persons over the age of 18. This may permit observation of numerical control operators at work. Shop helpers may be permitted some experience in machine-tool operation.

Methods for Entry:

To find a job as a numerical control tool operator, apply directly to factories or machine shops. Assistance in locating a job may be available from local offices of state employment agencies and from school placement offices. Job openings may also be listed in newspaper want ads.

EARNINGS AND ADVANCEMENT

Earnings of numerical control tool operators vary according to the type of machine operated, the size and geographic location of the employer, and the extent of unionization. Their wage-rate is slightly higher than the average for all production workers in manufacturing, but lower than the rates for such skilled machine workers as machinists and tool-and-die makers.

Earnings:

Nationally, numerical control machine-tool operators earned $29,556 annually in 1994. The low average for inexperienced workers was $19,636.

Oklahoma Salary:

Region	Range
Central	12.00-14.00
Northeast	9.00-13.00
Northwest	--
Southwest	--
Southeast	--

Fringe Benefits:

Fringe benefits depend on the employer and the union contract, if one is in effect. Most numerical control tool operators receive paid vacations and holidays, life, accident, disability and hospitalization insurance, retirement plans and sick pay. In some cases, employers and employees may contribute jointly to union trust funds used to pay for certain additional fringe benefits.

Career ladder for this occupation may look like this:

- Numerical Control Programmer
- Numerical Control Machine Tool Operator
- Skilled Machine Operator
- Semi-Skilled Machine Operator

Numerical control machine tool operators may advance to supervisory jobs. Operators with sufficient training in numerical control programming can move to the higher paying job of tool programmer.

EMPLOYMENT AND OUTLOOK

Numerical control machine tool operators held about 73,000 jobs in 1992. Most worked in such durable goods industries as metalworking machinery, aircraft and construction equipment. Jobs are concentrated in the metropolitan areas of the Northeast and Midwest.

Employment of numerical-control machine tool operators is expected to decline through the year 2005. Many jobs are expected to arise from the need to replace workers who retire or transfer to other occupations. Advances in technology will make the operators more productive and will limit the rate of employment somewhat.

Oklahoma Employment and Outlook

In Oklahoma, numerical control machine-tool operators are projected to have 59 job openings annually until the year 2000. Job openings represent new job growth and replacements caused by leaving the occupation, promotions, retirements, etc. In 1990, numerical control machine-tool operators held 1,030 jobs in Oklahoma. They are expected to hold 1,368 jobs by the year 2000. This is considered a fast growth rate.

Levels of education and training usually needed for this occupation:

- On-the-job training
- High school diploma or G.E.D
- High school diploma with vocational education

School subjects helpful in preparing for this occupation:

- Algebra
- Computer Science
- Geometry
- Trigonometry
- Blueprint Reading
- Drafting
- Machine Shop
- Shop Math

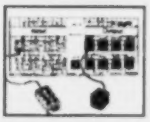
MORE SOURCES OF INFORMATION

- National Tooling and Machining Association
  9300 Livingston Road
  Ft. Washington, MD 20744

- Training Director
  Association for Manufacturing Technology
  7901 Westpark Drive
  McLean, VA 22102-4269

- National Screw Machine Products Association
  6700 West Snowville Road.
  Brecksville, OH 44141

- The Tooling & Manufacturing Association
  1177 South Dee Road
  Park Ridge, IL 60068



NUMERICAL CONTROL TOOL PROGRAMMER

NATURE OF THE OCCUPATION

Numerical control tool programmers plan and write programs, using appropriate computer languages and practical knowledge of machine tool operation, for numerically controlled machine tools.

Duties may include but are not limited to the following:

- Selecting cutting tools
- Analyzing parts drawings, sketches and design data to determine size and shape of cuts
- Determining machine speed and feeds
- Determining reference points and direction of cutting paths
- Computing angular and linear dimensions, radii and curvatures
- Outlining sequence of machine part operations
- Preparing geometric layout on graph paper showing cutting paths
- Writing instruction sheets and cutter lists to guide set-up and operation of machine
- Writing program sheet of machine instructions in symbolic language to encode control tape regulating tool movement
- Revising program to eliminate errors
- Observing trial operation of machine to prove taped instructions
- Writing instructions for the machine operator

WORKING CONDITIONS

Tool programmers work at desks in well-lighted and air-conditioned offices of manufacturing plants, separate from the noisy areas where machine tools are in use. They are usually supervised by a senior programmer or coordinator for numerical control and may work alone or with other programmers. Occasionally, they may observe or assist numerical control machine tool operators on the shop floor.

The average work week for tool programmers is 40 hours. Some may work evening or night shifts. Overtime may also be necessary during periods of increased production.

Tools, equipment and materials used may include:

- Calculators
- Computers and terminals
- Computer printouts
- Design data and drawings
- Reference tables and manuals
- Code sheets
- Automatic drafting and digitizing machines (machines that sense lines and curves on graphic input and convert them to numerical tape)

You should like:

- Doing work of a technical nature
- Working with blueprints, machines, processes and methods

You should be able to:

- Understand and use algebra, geometry and trigonometry
- Learn specialized, symbolic programming languages
- Picture objects from drawings and diagrams
- Organize data and make judgments and decisions
- Communicate with people at all levels
- Adjust to a variety of activities that change frequently
- Work under pressure
- Plan and direct an entire activity
- Work with precise limits or standards of accuracy

Physically you must:

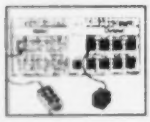
- See well, either naturally or with correction

Special Requirements:

Employers prefer to hire skilled machinists, or tool and die makers, or those with technical school training in tool programming. Those hired with previous experience in the metal trades must take courses in tool programming offered by vocational schools or junior colleges.

Opportunities for Experience:

To observe numerical control tool programmers at work, plant tours or school field trips to automotive and other manufacturing plants that use numerically con



NUMERICAL CONTROL TOOL PROGRAMMER

trolled tools may be available. Postsecondary programs in numerical control technology and robotics technology may provide opportunities for experience.

Methods for Entry:

The most common method of entry is direct application to employers. Assistance may be obtained from consulting college placement offices, local offices of the state employment offices and trade publications.

EARNINGS AND ADVANCEMENT

Earnings paid to numerical control tool programmers vary widely and are determined by job specialty, industry location and size of employer. Earnings tend to be higher in large cities than in small communities.

Earnings:

In 1994, numerical control tool programmers earned an average of $19,629 in the initial year of work, rising to an average of $27,380 per year after 10 years' experience.

Oklahoma Salary:

Region	Range
Central	10.00-17.00
Northeast	15.50-19.00
Northwest	--
Southwest	--
Southeast	--

Fringe Benefits:

Although fringe benefits vary, they usually include paid vacations and holidays, health, disability and life insurance, sick leave and pension plans. In addition, some employers provide tuition refunds for work-related training and school courses. Some employers may offer stock purchase/savings plans for salaried employees.

Career ladder for this occupation may look like this:

- Numerical Control Coordinator
- Senior Programmer
- Numerical Control Tool Programmer
- Trainee

Tool programmers may advance to supervisory jobs, or they may transfer to such skilled machining jobs as tool designer.

EMPLOYMENT AND OUTLOOK

Numerical control tool programmers held about 359,000 jobs in 1992. Almost all worked in manufacturing firms or machine shops producing such durable goods as aircraft parts, industrial machinery and instruments. Most jobs are in large metropolitan areas.

Employment is expected to decline slightly through the year 2005. Simplified programming languages will allow machinists to program the machines themselves reducing the need for programmers. Most job openings in this field will be a result of the need to replace workers who retire or transfer to other occupations.

Oklahoma Employment and Outlook

In Oklahoma, 4 job openings are projected annually for numerical control tool programmers until the year 2000. These job openings represent new job growth and vacancies caused by leaving the occupation, promotions, retirements, etc. In 1990, numerical control tool programmers held 105 jobs in Oklahoma. They are projected to hold 124 by the year 2000. This is considered an average growth rate.

Levels of education and training usually needed for this occupation:

- On-the-job training
- Technical, junior or community college

School subjects helpful in preparing for this occupation:

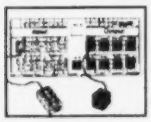
- Algebra
- Computer Science
- Math
- Geometry
- Trigonometry
- Business Data Processing
- Physics
- Blueprint Reading
- Machine Shop
- Metal Shop
- Shop Mechanics
- Drafting

MORE SOURCES OF INFORMATION

- The National Tooling and Machining Association
  9300 Livingston Road
  Ft. Washington, MD 20744

- Association For Manufacturing Technology
  7901 Westpark Drive
  MacLean, VA 22102

- The National Screw Machine Products Association
  6700 West Snowville Road
  West Breckville, OH 44141



ROBOTICS TECHNICIAN

NATURE OF THE OCCUPATION

Robotics technicians install, service, troubleshoot, maintain and repair robots and robot systems. Studies suggest that one operator is needed for every 6 robots, one maintenance person for every 8 robots and one engineer for every 15 robots.

Duties may include but are not limited to the following:

- Assisting engineers in design and appling robot systems
- Inspecting electronic components prior to robot assembly
- Inspecting and testing robots for defects after assembly
- Installing robots or robot systems at users' sites
- Providing start-up assistance to users, including qualifying (fine tuning) performance and accuracy of robots
- Training other technicians and skilled workers to operate, program, repair and service robots
- Keeping records of test procedures and results

OCCUPATIONAL SPECIALTIES

Hydraulic Press Servicers (621.381-018) repair, service and adjust hydraulic presses used to extrude wire for swaging into bullet slugs.

Controllers, Repairers, and Testers (825.381-018) adjust, clean, repair and test electric control equipment of commuter and rapid transit cars or streetcars, following wiring diagrams and using specialized equipment and handtools.

WORKING CONDITIONS

A successful robotics operation is the result of a well-trained team. The robotics technician may work with application and design engineers, machine builders and customers (if employed by a robot manufacturer). When in the field, the technician must work with the customer's engineers, technicians and maintenance personnel in the installation and servicing of robots. Robots are used in such jobs as spray painting, welding, assembly, die casting, machine loading and unloading, plastic molding, forging and heat treating.

Depending on the employer, robotics technicians may work in well-equipped test laboratories, in manufacturing operations of robot makers and/or servicing robots in users' plant facilities. Laboratory areas may be clean and well-lit while production areas may be noisy, hot, dirty or may have high levels of dust or fumes.

Robotics technicians work a 5-day, 40-hour week and some technicians work 10 or more hours overtime per week. Shift work may be required for those employed by robot users. Robotics technicians employed by robot manufacturers may travel for 15 percent to 75 percent of their time to install or repair robots or to train employees to operate and service the systems.

Tools, equipment and materials used may include:

- Hand and power tools
- Electrical wiring diagrams
- Programmable controllers
- Blueprints
- Oscilloscopes
- Manufacturers' technical and process manuals
- Multimeters
- Logic analyzers
- Microcomputers
- Chart recorders
- Lubricants
- Force gauges
- Laser interferometers (to check distance or thickness measurements)
- Videotape equipment (for training)
- Three-axis coordinate measurement machines

You should like:

- Activities of a scientific and technical nature
- Activities that involve the use of machines, processes, or methods
- Activities dealing with things and objects

You should be able to:

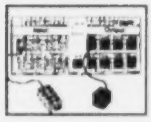
- Use reason and logic
- Work within precise limits or standards of accuracy
- Apply mathematics quickly and accurately
- Rate information using standards that can be measured or checked
- Look at flat drawings and visualize how they would look as solid objects with height, width and depth
- Communicate clearly, both orally and in writing
- Work easily and skillfully with your hands
- Coordinate the use of eyes and hands to perform tasks

Physically you must:

- See well, either naturally or with correction, and have normal color vision
- Use arms, hands and fingers well to reach for, handle and manipulate objects

Special Requirements:

Robotics technicians may receive certification from Robotics International (RI/SME). A robotics technician with 3 to 5 years' experience may be certified as an associate manufacturing technologist and, with 5 to 10 years' experience, may be certified as a manufacturing technologist. Academic training may be substituted for experience on a year-for-year basis. Applicants must pay an



ROBOTICS TECHNICIAN

application fee and pass an examination. Certification is valid for 3 years.

Opportunities for Experience:

Summer or part-time work is seldom available for robotics technicians. Building or repairing electronic equipment, radios or television sets will develop desirable skills. Postsecondary programs in robotics technology may offer co-op opportunities that include practical experience. At the postsecondary school level, individuals may join an RI/SME student chapter to learn more about robotics through technical programs, plant tours and on-campus conferences.

EARNINGS AND ADVANCEMENT

The salaries of robotics technicians depend largely on the technician's education, experience, and job responsibilities. The size and type of employer are also factors that affect salaries.

Earnings:

According to limited data, the salaries of inexperienced robotics technicians averaged $19,124 per year in 1994. Experienced technicians earned averages of $28,684 after several years on the job. Experienced technicians in supervisory or managerial positions earned from $38,376 to $48,831 or more per year in 1994.

In the auto industry, skilled trade workers such as electricians, industrial machine repairers, tool makers, and millwrights maintain robots. These workers earned salaries in 1994 ranging from $31,160 to $41,975 per year, to which cost-of-living allowances (COLA) are added. Technicians are also reimbursed for job-related travel expenses.

Oklahoma Salary:

Region	Range
Central	--
Northeast	--
Northwest	--
Southwest	--
Southeast	7.25-9.00

Fringe Benefits:

Depending on the employer, most robotics technicians receive paid vacations and holidays, life, accident, disability, and hospitalization insurance and retirement plans. Some employers have profit-sharing and/or tuition reimbursement plans. These benefits are usually paid, at least in part, by employers.

Career ladder for this occupation may look like this:

- Technical Trainer, Sales Representative, or Director of Automation
- Supervisor, Senior Robotics Technician, Design or Applications Engineer or Robotics Manager
- Robotics Technician
- Robot Operator
- Worker Trainee

Some robot users meet their demand for robotics technicians by placing their skilled or displaced workers in special training programs, usually conducted by the robot manufacturer or vendor. Graduates of postsecondary robotics programs usually complete their employer's in-house robotics training.

Advancement opportunities are very good for robotics technicians who are well trained with strong technical and programming backgrounds.

EMPLOYMENT AND OUTLOOK

Nationally in 1992, there were over 800,000 jobs involving robotic technology including tool programmers, machinists and numerical control machine operators. The expanding role of robotic technology will make this field accessible to those properly qualified, and opportunities should be plentiful.

Oklahoma Employment and Outlook:

No data available.

Levels of education and training usually needed for this occupation:

- On-the-job training
- Technical, junior or community college

Levels of education and training also available for this occupation:

- College - bachelor's degree

School subjects helpful in preparing for this occupation:

- Algebra
- Computer Science
- Math
- Geometry

MORE SOURCES OF INFORMATION

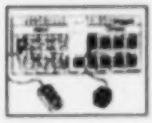
- IEEE Robotics & Automation Council
  c/o Institute of Electrical & Electronics Engineers
  345 East 47th Street
  New York, NY 10017

- Association for Unmanned Vehicle Systems
  1735 N. Lynn St., Suite 950
  Arlington, VA 22209

- JETS-Guidance
  1420 King St., Suite 405
  Alexandria, VA 22314-2715

TECHNOLOGY EDUCATION CONTROL ROBOTICS

DAY 8 ACTIVITIES



POSTTEST INSTRUCTIONS

You will need a computer scan sheet or card to record your answers to the following Posttest. Be sure to write your name, the title of the TLA, the date, and the class period on the computer scan sheet or card using a #2 pencil. Use rows 11–20 to record the answers to the Posttest. If your answers will be hand-scored, use a blank sheet of paper to record your answers and number your answers 11–20. Use rows 21–30 on the test card for the spelling test. If the word is spelled correctly, mark (a) on the computer score sheet or card. If the word is spelled incorrectly, mark (b) on the test card. Be sure to use a #2 pencil and make your marks dark. If your answers will be hand scored, use a blank sheet of paper to record your answers and number your answers 21–30.

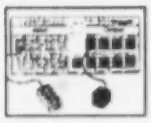
Get Posttest Questions from your instructor.

When you finish the Posttest, return the test form and the computer scan card or notebook paper to your instructor.

If you complete Day 8 Activities with time left over, you may complete a Skunk Works activity.

TECHNOLOGY EDUCATION CONTROL ROBOTICS

SKUNK WORKS



BACKGROUND

The term Skunk Works comes from an engineering division of the 3M Company. In the late 1960s, a group of engineers at 3M wanted to design a new product, but the managers of the company would not give them the money for research. So they decided to design the product anyway, then try to convince the company to market it. Whenever the engineers could grab a few extra minutes from their regular assignments, they worked on the new product. In early 1969 they presented it to the marketing division of 3M, and the company has been selling it every since. The product: Velcro fasteners.

SKUNK WORKS CHALLENGE

For this Skunk Works activity, you will be designing and testing a method of controlling a two-motor robot using a light sensor.

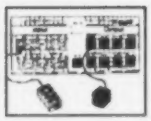
You will need the following:

- LEGO DACTA® Control Lab™ System that includes a properly connected computer, serial interface and transformer; a Control Lab™ Mod disk; and a Control Lab™ Technology set (9701)
- the wheelchair used in the earlier activities
- a light sensor
- a wide-tipped permanent black marker or black electrical tape
- a sheet of white paper at least notebook paper size

INFORMATION

Many control device use optical sensors to "see" what is happening in the world around them. Just as people see through their eyes, the computer get input from the optical sensor when variations in light intensity are detected.

Many supermarkets use bar code scanners at the checkout counters to record the price of the items and to automatically update the inventory by tracking what is sold. Those rectangles with the stripes on the backs of packages are



known as UPC or Universal Price Codes. The scanners in the supermarket use a laser light and an optical sensor to detect the difference between the black and white areas and the relative width of each area. The pattern of the bands is fed into the computer. Each product has its own special pattern. The computer processor can distinguish one pattern from another so it can register exactly what product is being purchased.

Using optical devices as sources of input is becoming more and more common.

Follow the instructions below.

STEP 1: Connect the motors of the wheelchair model to output ports A and B on the interface box.

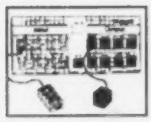
STEP 2: Tilt the foot rests of the chair into a vertical position and attach the light sensor to both footrests with the red LED facing your desk.

STEP 3: Attach the light sensor to input port 7 of the interface box.

STEP 4: Follow Steps 1–3 from Day 1 (page 19) to turn on the computer and load the appropriate software. Select and open the **snfdog** project.

STEP 5: A picture of the Control Lab™ interface box showing Input Port 7 with a light sensor in place and Output Ports A and B with motors in place. The icons on the Setup page should now be the same as the sensors and motors that are connected to the interface box. Click on the dots above the motor icons to ensure that the wheelchair motors are connected and working properly.

STEP 6: From the **Pages Menu,** select **Page 1.**



STEP 7: Using a black wide tip marker or black electrical tape, make a path for your model to follow. The pathway should be at least ½" wide and should not cross over itself at any point.

STEP 8: Place the light sensor on the white paper and observe the "scent" monitor. Place the light sensor over the black line and observe the "scent" monitor.

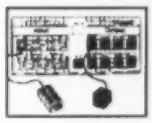
STEP 9: Place the wheelchair model on the paper with the light sensor pointing toward the surface. The sensor should be as close to the surface as possible without touching. Place the sensor so it is directly over a black line.

STEP 10: Click on the **Hound Dog** button to start your model sniffing. Observe the "scent" monitor as the model sniffs its way along the black line.

STEP 11: Click on the **Down Boy!** button to stop your model.

STEP 12: From the pull down **Pages Menu** select **Procedures.** Look carefully at the procedures, and try to explain how each command will effect the action of the model.

STEP 13: Before quitting, find out from your teacher whether you should save your work. Exit the program by selecting **Quit** from the **File Menu**. When asked whether you want to save your work, follow your teacher's instructions.



☑**NOTE: The save default is Yes so be sure to change to No if your teacher says not to save. Do not save anything unless told to do so by your teacher.**

STEP 14: Turn off the computer by following your teacher's instructions. Store the assembled wheelchair for later use. Return all other materials to their proper storage areas and clean up your work area.

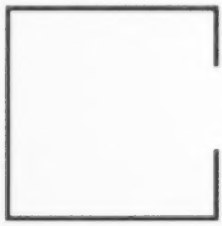
If you have time, complete one or more of the the optional activities that follow.

Optional Activity 1

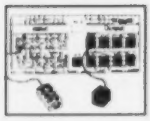
STEP 1: Change the program to make the model follow a white path between two black areas. Just for the record, it isn't as easy as it may seem, so don't get upset if you run out of time.

Optional Activity 2

STEP 1: On another sheet of white paper, draw a square measuring at least 7" x 7" (the bigger the better). With the black marker or black tape, trace over three sides of the square. On the fourth side of the square, leave



an opening at least 5" wide. Your square should look similar to the one below.



STEP 2: Place the wheelchair in the center of the square facing away from the opening. Write a program that makes the wheelchair, sensing the light and dark surfaces, find its way out of the square without crossing the black line.

STEP 3: After you have successfully programmed the wheelchair out of the square, expand your project by adding one or more of these finishing touches.

- Make an alarm sound when the wheelchair touches the black line.
- Use the joystick to control the wheelchair.
- Create buttons to stop, start, and control the wheelchair.
- Show monitors to sense the percentage of light on the sensor.

STEP 4: Before quitting, find out from your teacher whether you should save your work. Exit the program by selecting **Quit** from the **File Menu**. When asked whether you want to save your work, follow your teacher's instructions.

☑**NOTE: The save default is Yes so be sure to change to No if your teacher says not to save. Do not save anything unless told to do so by your teacher.**

STEP 5: Turn off the computer by following your teacher's instructions. Store the assembled wheelchair for later use. Return all other materials to their proper storage areas and clean up your work area.